DOCUMENT RESUME

ED 094 773	IR 000 974

TITLE	Computer Services; Universities.
INSTITUTION	Academy for Educational Development, Inc., Washington, D. C. Management Div.; Ohio Board of Regents, Columbus. Management Improvement Program.
PUB DATE	1 Jul 73
NOTE	128p.
EDRS PRICE	MF-$0.75 HC-$6.60 PLUS POSTAGE
DESCRIPTORS	Computer Programs; *Computers; Cost Effectiveness; *Delivery Systems; Higher Education; Interinstitutional Cooperation; *Management; Organization; Planning; Resource Allocations; Staff Role; *University Administration
IDENTIFIERS	Computer Services; *Ohio

ABSTRACT

A guide for the management of computer services in Ohio universities is given to enable university administrators to better plan the initiation and development of computer services and to provide criteria to measure the adequacy of their present services. The information contained is applicable to all universities and emphasizes the variety of practices to be found. Management is the key concern and is explicated in the following areas: planning (the development of goals and objectives), costs (the types of financial arrangements possible and the proper relationship of costs to income and institution size and needs), internal procedures, staffing and organization (internal organization and relation of computing services to the rest of the university), inter-university cooperation (time sharing and remote terminals). The detail and language of computer services relevant to management decisions are contained in this manual. Several appendixes describe aspects of computer services at different universities. (WH)

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OHIO BOARD OF REGENTS • MANAGEMENT IMPROVEMENT PROGRAM

COMPUTER SERVICES
UNIVERSITIES

MD

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This book represents one of five manuals prepared under the direction of the Ohio Board of Regents' Management Improvement Program which the Management Division has arranged to distribute. We feel that the recommendations and procedures contained in these manuals are of enough general interest and applicability to warrant sending them to persons outside the Ohio public universities.

The Management Improvement Program was established by the Ohio State Legislature in December 1971 to consider means of improving the management of the state-supported universities and junior colleges. Gerald L. Shawhan was the Director of the Program.

In addition to the five manuals which the Management Division is distributing, five others on the same subjects have been prepared covering the public two-year colleges.

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Management Improvement Program
Ohio Board of Regents

MIP

Prepared by a task force of university representatives with direction and staff assistance provided by The Ohio Board of Regents

July 1, 1973

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Foreword

This manual is one of ten completed in the Management Improvement Program (MIP) during the 1971-73 biennium. In this project, Ohio's 34 public universities and colleges, in an effort directed and staffed by the Ohio Board of Regents, have developed manuals of management practices concerning institutional planning, program budgeting, personnel management, computer services, and schedule building and registration. The project is unique in at least two ways—the improvement of internal management processes is the objective of the program, and the method of undertaking it was mandated by the Ohio General Assembly to be participatory.

House Bill 475, the appropriation act passed by the 109th General Assembly in December, 1971, created the MIP, directing that it be conducted by and within the system of state assisted universities and colleges under the direction of the Ohio Board of Regents. This legislative action culminated more than four years of active interest by the legislators in improving the management practices of these schools.

In 1967, a joint House-Senate committee, called the Education Review Committee, was created by the General Assembly. Included in its charge was that of monitoring the management practices of the public universities in Ohio. This committee, in conjunction with the Department of Finance, hired a management consulting firm to perform a management study of the nonacademic areas of the 12 public universities and of the state system as a whole. The report of the consultants, published in December, 1969, made about 100 specific recommendations for management improvement. The Education Review Committee remained interested in appropriate follow-up of the study. With the aid of another individual consultant, language was introduced in the General Assembly which was included in the appropriation for the biennium. Some excerpts of the actual language are as follows:

> "The purpose—shall be to design, test, and install, in each such institution, the most efficient feasible internal organization, planning process, financial management, budget preparation and management, auxiliary services management, space management and plant operation, purchasing procedures and inventory control procedures, student data systems including admission procedures and student registration procedures, management reporting systems, data processing, personnel management, and library management.
>
> Each project is to be conducted in cooperation with a committee of representatives from state assisted colleges and universities.
>
> The director of each project is to be a staff specialist in the employ of the Board of Regents.

For guidance in the conduct of each Management Improvement Project, the participants are to consult the findings as set forth in the 1969 Consultant's Report."

Primarily because the appropriation to carry out the program was not commensurate with the depth and breadth of the tasks spelled out in House Bill 475, the scope of the Management Improvement Program in this biennium was restricted to five central areas (Institutional Planning, Program Budgeting, Computer Services, Schedule Building and Registration, and Personnel Management). In addition, the original mandate of H. B. 475 was "to design, test and install the most efficient, feasible procedures" in each of the areas in each of the institutions. Because of the limited time, only 18 months, and the participatory method of undertaking the project prescribed in the bill, the immediate objective set forth in the past biennium was the generation of a manual of best practices in each of the five areas.

As stipulated by the legislature, task forces of institutional representatives were appointed and actively participated in the process. Ten such groups were formed—five for the universities and five for the community and technical colleges. Each task force consisted of representatives qualified in the particular subject matter under study. Each group had at least one member from every school. In total, more than 175 college and university personnel from all over the state were directly involved, as well as many others at each institution through formal and informal contact with the appointed members. Each task force met 8-10 times in the year and a half devoted to the project.

As specified in the legislative bill, the Ohio Board of Regents provided direction and staff for the project. Four professional management analysts, two secretaries, and limited part-time analytical and clerical help constituted the manpower to fulfill that charge.

Three major phases constituted the project:

1. **Inventory the current practices.**
   This phase involved compiling the existing practices and procedures in the five areas at each state-assisted school in Ohio. Approximately five months were devoted to this task.
2. **Determine the issues to be addressed in the manuals.**
   Three months were devoted to discussions about the specific issues to be covered.
3. **Write manuals.**
   Nine months were devoted to writing the manuals. This phase included extensive and detailed discussions by the task forces, much drafting and redrafting by the staff and task force members, and finally concurrence with the manual contents.

The manuals are practical, informative and useful. For the most part, all of the manuals contain general guidelines, principles and broad recommendations for good management within the universities and colleges, rather than detailed and specific procedures. They also include recommendations which call for direct action by the Board of Regents. Basically, the recommendations seek more effective internal management and accountability, while recognizing the autonomy of each school.

Literally hundreds of people have been involved in this project. All members of the Ohio Board of Regents staff, especially former Chancellor John Millett, and Vice Chancellor William Coulter, have made significant contributions to the entire project. The Regents were particularly fortunate in gathering together the staff for the MIP. Dr. Ronald Lykins, Mr. Lawrence J. O'Brien, Mr. Douglas Smith, and Dr. Joseph Tucker brought with them considerable experience and knowledge from administrative and academic aspects of colleges and universities, as well as from private industry. Their perseverance and leadership in directing and staffing the task forces were superb. Special thanks must be given to Mrs. Betty Dials, the secretary for the program, who was an inspiration to all.

Many agencies in other states, including colleges, universities and state systems, were contacted and in some cases contributed helpful data to the program. Applicable professional organizations were also contacted and did help.

But more than any other, however, the contributions made by the individual task force members must be mentioned and expanded upon. The more than 175 personnel from the 34 colleges and universities who were the official representatives for their schools contributed long hours, data, ideas, constructive criticisms, changes, and encouragement. They not only worked collectively in the task forces, but also were required to spend considerable time on the respective campuses gathering data together and communicating with many campus constituencies to make sure that their schools were fairly and adequately represented.

The university computer services task force members were:

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Without their sincere participation, this manual would not exist.

Gerald L. Shawhan, Director
Management Improvement Program

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Preface

Productivity is one of the words most often heard nowadays in higher education and the context is typically "How can we increase productivity?" Computers can and should be employed in higher education to meet the demands for increased productivity as they have been utilized to increase productivity in other service and non-service industries over the last decade. To maximize the impact on productivity the University Computer Services function must expand to meet the increasing needs of the instructional, administrative, research and public service areas of the institution. With this expansion comes the need to wisely and efficiently use the institutional resources to best satisfy the various computing needs of the users. Ohio's universities recognize this need and are striving to improve the management of computer services on the campuses.

As one step in the process this manual has been developed with a number of purposes in mind. First, the overall aim in developing the manual has been to document specific recommendations for desirable management practices in each of the areas of computer services. Thus the intent was to make the manual useful for the various institutions in their quest to improve their own management practices. Another purpose has been to make available to the institutions some criteria and guidelines that can be used to measure their own performance. Finally, a purpose has been to provide a logical and organized discussion of the process of providing computer services to institutional planners, administrators and others.

The law creating the Management Improvement Program directed that the findings of the Warren King study of 1969 be consulted, and insofar as the Task Force finds the recommendations valid and feasible, the recommendations should be implemented.

Warren King had addressed the topic of computers heavily. Two major recommendations were the establishment, funding and control of statewide higher education computer resources in three Board of Regents managed regional centers and the uniform development of systems and procedures at the Board of Regents level.

The Task Force, during this phase of the MIP, concluded that regional computer centers operated and funded by the Board of Regents was neither a valid nor a feasible approach to providing computer services cost effectively.

Rather the Task Force embraced the idea that inter-institutional cooperative efforts, such as those presently underway within the state should be pursued and promoted. In this vein the Task Force recommends that a Statewide Plan for Sharing Computer Resources be developed during the next biennium that will guide and direct future efforts.

Regarding state level development of uniform administrative systems and procedures the Task Force again rejected the Warren King recommendation. In its place the Task Force recommends the establishment of an inter-institutional committee active in administrative data processing that will be charged

PREFACE

with inventorying, sharing and developing in common where appropriate, those administrative systems commonly used at many institutions.

To achieve management improvement through implementation of the recommended practices in this manual will require a commitment of the institutions, the Ohio Board of Regents and the Ohio General Assembly. Most notably in this will be the requirement for the universities' presidents and senior level administrators to become genuinely involved in the decision making in the computer services area. They must make the decisions regarding the level of institutional resources devoted to computer services and in what manner these resources are most productively utilitzed.

The development of this Management Improvement Program Computer Services Manual has been accomplished through a spirit of cooperation among the universities and the various Task Force members. Credit should be given to these Task Force representatives who devoted their time and energy in order that a good manual results. The Management Improvement Program within Ohio is a clear indication of the desires of Ohio's publicly-supported universities to improve their internal management practices.

Lawrence J. O'Brien, Director
Computer Services Task Force

COMPUTER SERVICES

Universities

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1. Introduction

Role of Computer Services in Higher Education

The role of the computer in higher education is considered by some to be as important as the introduction of the written word or the textbook. The impact the computer can have on higher education is almost without bounds.

The computer's role within the universities occurs in three distinct forms: as a **subject of study** within the universities because of the computer's impact on society, as a **tool** because of the effects of the computer on the process of education and its administration and as an **agent of change** because of the effects the computer can have on the internal and external structure of the university.

One of the first and lasting effects of the computer on higher education has been the generation of the requirement that the university develop methods for providing computer services to students, faculty and staff. The possible mechanisms are numerous, and an essential set of decisions on campus must involve determining the most effective and efficient methods to provide all users with needed computer services.

Scope of Computer Services

Almost every student, academic department and administrative organization on the university campus can be assisted by computer services. Students, faculty and staff are now utilizing computers in numerous applications on Ohio's campuses. Some examples are:

- Computer Assisted Instruction (CAI)
- Computer Theory and Computer Application Education
- Test Scoring and Student Performance Analysis
- Computer Managed Instruction (CMI)
- Library Acquisitions, Cataloging and Circulation Control
- Program, Planning, Budgeting Systems
- Registration and Scheduling
- Accounting and Financial Applications
- Political and Historical Data Analysis
- Statistical and Mathematical Research
- Analysis of Chemical Structures
- Business Modeling and Simulation
- Agricultural Data Analysis
- Patient History Storage and Analysis
- Dispensation Systems Within Hospitals
- Inventory Control

INTRODUCTION

The computer services function must be responsive to all appropriate requests for service, and must simultaneously provide cost-effective service to each of its users.

Problems Associated with Providing Computer Services

The problems associated with the delivery of computer services to all the varied users are not easily solved. Some of the problems which complicate the computer services management process are:

1. The range of different types of users is very large—perhaps larger than in business or government. Each of these many users, approximately one quarter of a million within Ohio's public universities and colleges, exhibits different needs and requires a wide variety of services.
2. The costs of computers and the related hardware and software are significant, and computing expenditures have grown rapidly within Ohio's universities. These expenditures should be justified on a cost-benefit basis. However, it is not always easy to justify cost-effectiveness for certain applications since the value of the output is often difficult to quantify. (Examples are on-line registration and computer-assisted instruction)
3. The computer which represents a significant portion of the institution's resources is typically not well understood by the top level decision makers. Exaggerated claims by vendors often have not materialized and have caused some decision makers to be wary. In addition, the dynamics of the field and the language of the profession make it much more difficult for upper management to exert an active, forging influence.
4. Capabilities of computer hardware and software have changed rapidly in the past and will continue to change. Hence, in an area so dynamic as this one, personnel must stay abreast with changing technology since old assumptions do not necessarily apply to new problems.
5. The capabilities or potential of the computer can be more fully exploited on most campuses throughout the nation.
6. Many of the future needs of the users are anticipated or identified by the computer service organization rather than the request being user-initiated.
7. Computer services can be adversely affected by lack of communications within the university. This is a significant problem in administrative data processing (ADP) in the area of consistency of data bases between organizations on campus.

Definition of Computer Services

Computer services as used in this manual refers to the process by which the capabilities of computers or related equipment are utilized to assist people at the institutions (students, faculty, administration, medical and other researchers, public, other institutions) in accomplishing their objectives. As the name implies, computer services are service functions. These services may be provided in the gathering, storing, preparing, processing, displaying, or reporting of information in the instructional, research, public service and administrative areas of the university.

Types of Users and Examples of Their Needs

1. **Instructional Users**—These include students learning languages, faculty using the computer as a demonstration tool, faculty using it as part of a course for delivering materials (computer-assisted instruction) or quality control and evaluation (computer-managed instruction). Instructional user needs frequently include good instructional languages, fast turnaround, interactive time-sharing, and on-line capabilities for computer-assisted instruction and computer-managed instruction.
2. **Research Users**—These include faculty and graduate students writing their own program or using generalized library programs for calculations and analysis of research problems; data collection and analysis for major research ventures (e.g., radioscopy, chemical and nuclear analysis, census tract data). Their needs include many languages, specialized measuring devices, a powerful library and high speed core.
3. **Public Service Users**—These users include those requiring testing, analysis and data collection functions for various public service ventures such as: soil testing for farmers; cooperative extension management tools; external degree or extension teaching support; services to high schools and other agencies. The needs include interviewing staff to provide packages tailored to specific nontechnical users.
4. **Administrative Users**—These generally are supervisors through top management who desire an increase in efficiency, speed, or integration of processing of data with some modest concurrent desires for analysis. Examples include student, faculty, space and financial records with specific functional support of such things as registration and scheduling of students, general stores inventory control, financial cash flow planning, dormitory room assignment, bookstore inventory control, scheduling maintenance. Their analytical desires include modeling, forecasting, cost studies and resource analysis models. Their needs include a significant need for technical support in both problem definition and systems design as well as for programming and operational control of the integrating and timeliness of data bases. The languages used in administrative data processing should be closely controlled and all programs well documented.

Purpose or Role of Computer Services

The purpose of computer services is to assist in providing computer-based resources (human, hardware, software, methodology and information) so that the various users on the campus can attain their objectives in the most efficient manner. These objectives cover a wide spectrum. Among typical uses of computer services are such specific uses as planning for efficient operation of dining halls, assisting a registrar diminish waiting lines, assisting a faculty researcher solve a problem, and training a student in elementary medical theory.

Computer services personnel also serve in an advisory or staff role within the university by providing advice and counsel in areas such as curriculum committee decision-making, administrative systems evaluation and management decision-making.

The budget of computer services limits the level of human and hardware resources available. Within this budgetary constraint, the effective use of the human, hardware and information resources to perform a service can be measured in terms of:

1. The responsiveness to the service needs of current and potential users.
2. The degree to which the service is performed in terms of:
    (a) Throughput—total amount of work performed over a given period
    (b) Response Time—time between initiation of request and receipt of results
    (c) Availability—degree to which service is available when needed

Primary Objectives of Computer Services

Among the primary objectives of computer services are to provide:

1. the computing resources necessary to support that proportion of instruction and the educational process to be carried on through informational technology.
2. the means to acquaint all students, faculty and administrators with an understanding of the importance and pervasiveness of computers.
3. information processing support to those administrative areas where increased effectiveness and better business practices warrant the additional computer service expenditures.
4. in accord with top management directive and guidelines, development and implementation of large scale data base concepts to assist management planning and control.
5. information processing for areas of research and public services in accord with the institutions' objectives in these areas.

Activities of Computer Services

As the name implies, the overall function of computer services is to provide a service to the university. This service can logically be divided into a systems development activity and a computer operation activity. These activities can be further subdivided as follows:

1. Application Systems Design—defining problem and methods for solving problem in terms of an application of a computer to data.
2. Aplication Systems Programming—writing or selecting the programs that will process the data in accordance with the design requirements.
3. Operating Systems Design and Programming—providing scheduling support to operations and programming tools for application programmers.
4. Data collections, conversion and storage.

5. Production control services. (e.g., operations, scheduling, report balancing)
6. Computer Operations—operating the equipment required to process data by programs according to schedules.

Computer Services Management Process

To serve the computational needs of the entire university community, the computer services organization must accomplish the following series of actions:

1. Evaluate, in concert with the various users, the long-term and short-term computational needs of the university community.
2. Determine the strategy of computer services with regard to the above needs in accord with top management policy, and institutional goals and objectives (i.e. which needs will be addressed; which needs will be deferred to a later date)
3. Develop a series of alternative activities to achieve the goals and objectives within the limits of available resources.
4. Evaluate alternate series of activities.
5. Implement selected activities for acquisition of equipment, software, space and personnel.
6. Measure and evaluate service in relation to both the current needs and possible alternative use of available resources.
7. Manage all computer resources including the systems development activity and the operations activity in the most cost-effective manner.

Purpose of Manual

The purpose of the manual can be described from a number of vantage points. First, it is important to understand that there is need for such a manual. It has been generally acknowledged that computer services management often needs improvement. That is not to be taken in a negative sense, since one can always improve, (i.e. "you **can** argue with success.") Further, such problem areas as lack of long-range planning, lack of inter-institutional cooperation, lack of upper management familiarity with data processing capability have been indentified by the studies of Warren King and Associates, Inc., and others. In most instances the validity of several of these problem areas have been widely accepted.

Primary Purpose

The primary purpose of this manual is to document specific recommendations for desirable management practices in each of the areas of computer services. The intent is to make the manual useful for the various institutions in their quest to improve their own management practices. Many institutions were already planning changes in their present practices and procedures. This manual can indicate the direction these changes may take. Other changes toward the recommended practices will undoubtedly come about through a self-study by each institution and through the awareness that these recommended practices are successful in other institutions. Particularly important will be the opportunity for many less experienced institutions to study and possibly implement the methods of the more experienced and the better equipped schools. This is especially true in the dynamic areas of computer services, where technological change and managerial innovations continually change the demands for computer resources.

Secondary Purposes

Another purpose served by the manual is the availability to the institutions of a yardstick that can be used to measure their own performance. The guidelines or criteria presented in the various areas will enable the institutions to judge how well they are utilizing the resources available for computer services on their campus. An attempt has been made to provide quantitative criteria wherever possible. Where this was not feasible, guidelines of a qualitative nature are included to assist the user.

A third purpose of the computer services manual can be described as educational in that an attempt was made to provide a logical and organized discussion of the process of providing computer services. This discussion should be of value to a broad spectrum of administrators and faculty on each campus as well as those directly responsible for the planning and provision of computer services.

The participatory process followed in developing the manual has and will continue to help improve computer services management in the various institutions. Specifically, the task force formed to work in conjunction with the Board of Regents staff has caused the various institutions to become more aware of what each is doing and to facilitate an exchange of information. This information exchange is not the first step in the overall process of increased inter-university cooperation in the computer services area since the Inter-University Council subgroup on Administrative Data Processing (IUC/ADP) has worked for the exchange of information for two years.

Summary of Purposes

The primary purposes of the manual can be summarized as follows:

(a) To provide a means for sharing the effective computer services practices that have been developed at different institutions.

(b) To provide practical and useful ideas which can be used to improve computer services practices at the individual institutions.

(c) To provide some criteria and guidelines which can be utilized by individual institutions to evaluate their present processes.

(d) To provide computer service planners, administrators and other interested parties, with a logical and organized discussion of the process of providing computer services.

Disclaimers

In order to better understand the intended use of this manual, it is important to emphasize that which the manual does not purport to accomplish.

(a) The manual does not prescribe the one best practice for many of the areas of computer services, simply because it is impossible to define a best practice in those areas. In coming to a determination of best, there are typically different indices of performance that may be minimized or maximized (i.e., are we trying to minimize cost or maximize performance or maximize service or minimize time, etc.). In addition, the resources available will also affect determination of best, in that the resource level can constrain the possible approaches. However, wherever a practice was considered best for the entire spectrum of institutions, it was recommended. In instances where a given practice is expected to vary markedly among the institutions because of local constraints, a number of recommended practices or guidelines are included.

(b) The manual is not intended to be a rule book. It cannot be followed indiscriminately, thus decreasing the number of decisions to be made by computer service management at each school.

(c) Uniformity for uniformity sake was not sought. Where it appeared that uniformity would result in an improvement in the effectiveness of computer services, it was recommended. However, the real and significant difference between institutions, in emphasis, organization, tradition, environment, etc. are recognized and taken into account.

(d) Recommended practices and guidelines were generally agreed to by the participants, although there was not always unanimous agreement on all issues.

(e) Practices which are currently best may be antiquated by rapid changes in technology. Hence, there is a constant need to assess what practices are "best" under prevailing technology.

2. Planning Process

Introduction

It should come as no revelation that dollars and time invested in computer services planning can be returned many-fold in effectiveness and economy of utilization. Any effective organization requires planning, especially long-range planning, if it is to be successful at utilizing its available resources. This requirement is magnified for a university computer services organization primarily because the needs of the various users and the technology are both so dynamic. Thus planning must be directed toward the mechanism of change.

This chapter will discuss the general process of planning and then proceed to concentrate on the process as applied to computer services. The steps and outputs of the process will be discussed together with appropriate definitions. Emphasis will be given to those facets of planning, such as determination of goals and objectives and comparison of alternatives that are most critical. Long-range planning, covering a period of 3-5 years will be stressed in the chapter since the long-range planning process will result in a detailed short-range (one year) operating plan thus saving considerable duplication of effort.

General Planning Process

Planning is generally accepted as the first of the four functions of management. The others are organizing, implementing and controlling. Since planning is the first, thus forming the basis for the other functions, it can be considered the most critical. However, planning typically is not given the needed attention since there is no immediate payoff. One author has summarized the crucialness of planning, "If you can't plan it, you can't do it." This might be more aptly stated, "If you haven't planned it, you probably shouldn't do it."

Computer services long-range planning is particularly critical for a number of reasons:

- rapidly changing character of the systems and computing field
- changing nature of user needs
- scarcity of resources (primarily capital and talent)
- lead time required for development of complex systems
- lead time for equipment acquisition
- lead time for physical facilities
- changing nature of the computer services market place

The planning for the computer service function within a university is similar to the planning of any organizational entity, yet it does involve unique factors that need to be addressed. The general planning process will be described first, followed by those issues affecting computer services planning.

PLANNING PROCESS

Steps in the Planning Process

The planning process is defined as a management process that attempts to predetermine a course of action. The process is both cyclic and iterative and calls for each organizational unit in an educational institution to accomplish the following steps:

1. Establish goals and objectives
2. Determine alternative programs to achieve objectives
3. Calculate resource requirements for programs
4. Determine priorities of programs
5. Allocate resources to highest priority programs
6. Evaluate program progress at appropriate milestones

Definition of Terms in Process

Definitions of the key terms used above are summarized here:

Goals — the desired end result set for a program — generally set for a long period of time (i.e., 5-10 years). Goals and objectives are often used interchangeably but they differ in terms of time frame, sequence and measurability. Goals are long-run and the end result. Objectives are short-range and are steps in the direction of attaining a goal.

Objectives — the measurable attainments or desired results set for programs over a short period of time (i.e., one year). Objectives are generally regarded as progressive steps toward a goal. Thus, a series of objectives should lead to one's goal.

Objectives should be **written** and meet the following requirements. They must:

1. Relate to a goal
2. Be measurable or observable
3. Specify the method of measurement and criteria for evaluation
4. State the time period for achievement

Programs — a group of related activities used to achieve a goal or objective.

Alternatives — collection of different programs to accomplish the same objectives or goals.

Resources — personnel, space, operating support services and equipment which are converted into dollars and cents.

Priorities — establishing the relative importance of specific activities.

Allocating — subdivide, schedule and assign the available resources among different activities.

Evaluating — a systematic process for determining or estimating the effectiveness of a particular program or program component. Evaluation of programs is based upon a comparison of actual results with desired results or objectives.

Milestone — a significant point in the program development. The number of milestones in a program, leading to the accomplishment of a goal or objective or to the conclusion of the program, is determined by the time interval between them. This interval of time must be such that missing a given milestone does not jeopardize the program (i.e. there is enough time remaining to rectify and recover). A specific time interval cannot be recommended "across the board"; it depends on the range, scope and nature of the program plan and the personnel involved.

Outputs of the Process

The planning process results in plans, which are the output of the process. The plans should be a documentation of the entire process. They should be formal written documents that state the goals and objectives, the programs and activities considered, the assumptions made and the analysis used, the conclusions regarding programs to be pursued, the allocation of resources for these programs and activities and the policies that are to govern the use and disposition of the resources. The plan must include milestone dates that can be used for control of the activities or programs. It is recommended that the milestones be spaced such that missing of any one milestone does not jeopardize the plan or the ultimate objectives.

Computer Services Planning Process

As with any service organization the planning process must begin with an assessment of the users expressed needs. These needs, together with the goals and objectives of the university, can be used to establish the computer services goals and objectives. A number of issues affecting the goal setting are discussed in this section. The comparison of alternatives for computer services and the types of plans that result from the process are described.

Time Span of Process

The planning process, as defined herein, is a cyclic process, phases of which should be constantly in progress within the computer services organizational unit. The planning process results in outputs called plans, that may be categorized as short-term or long-term with the degree of detail decreasing as the term is increased. Reasonable detail is required for the first year of the long-range plan; this first year plan will be a short-term operating plan and will minimize the amount of additional short-term planning necessary. It is recommended that computer services formalize long-range plans (5 years) to assist institutional management and itself better utilize the resources available. The planning process should be formal including requirements for written plans and specific organizational and procedural machinery for review, evaluation and approval. These long-range plans are necessary to assure that the objectives of the institution and the computer services organizational objectives are being simultaneously satisfied.

Elements of Computer Services Planning

To make the planning process described above more useful to computer services planners and those studying the subject, additional details and emphasis are necessary. In addition to expanding upon the crucial steps in the process, the elements that should be addressed in a planning document should be examined. These elements include:

Users Expressed Needs:
- statements of types of users needs
- statement of users future needs

Goals & Objectives:
- statements of university's goals and objectives
- statements of computer services goals and objectives

Present Performance:
- assessment of current status and degree to which users needs are fulfilled
- assessments of major strengths and weaknesses

Environment
- forecasts of technological developments in hardware, software, personnel practices and management techniques

Functional Classification of User Needs

Activities to satisfy users needs on university campuses can be categorized in a varied number of ways. These include the mode of user access (batch processing, interactive time-sharing, dedicated computer), source of service (on-campus decentralized or centralized, off-campus commercial or consortium) and types of users (instructional, research, public service, and administrative).

The Task Force feels that users needs can best be categorized along broad functional lines. Within the universities three functions of computing seem logical:

1. Teaching Computer Languages and Concepts
2. Problem Solving
3. Production Processing

Teaching Languages and Concepts

Teaching Computer Languages and Concepts primarily involves the instructional users and is the most universal application of computing in higher education. The FORTRAN language is most frequently used to train students in Ohio although COBOL, BASIC, APL, ASSEMBLER and PLI are also used in programming classes. Incorporated in such courses are discussions of basic computer concepts, but the primary goal seems to be language adeptness. The student is expected to key-punch his own cards or operate his own terminal, but in general, he is not expected to operate the computer. The principle method of providing this service is through batch processing where student jobs are submitted and later picked up at a particular center. Interactive student programming has been provided as a means for teaching languages and will gain significantly in academic use. Here the student uses a terminal to write and debug his program. Because the response to many errors is immediate much less time is required to get a program operating. Interactive student programming is characterized by both a load which approximates the peak activity hours of the university as well as the necessity for complex system software to control the interactive process.

There is also training available in less frequently used languages (e.g., SNOBOL, ALGOL, SIMSCRIPT, GPSS) and in various specialized applications of computers such as graphics and CAI.

Students involved in learning computer languages and concepts need some consultation and educational advise regarding hardware and software. They also need fast turn-around for batch processing and online capability for student terminal use including computer-assisted instruction and elementary problem solving.

Problem Solving

The use of computers in problem solving covers a broad spectrum. It ranges in complexity from simply providing a compiler which a researcher or data processor can use to write programs designed to solve problems, to providing elaborate statistical and data manipulation packages and a standard data base for extensive research. The simplest function, compiling and testing services, is very similar to the teaching function whereas the more complex problem solving applications overlap somewhat with production processing. However, in the midground, there is a significant amount of activity supported in the development of complex programs and in providing "one time" calculation services.

Students and faculty both use the computer in the problem solving mode to support the instructional and research processes. There is also limited problem solving use by administrative, (eg., modelling, Institutional Research) and Public Service (eg., one-of-a-kind data analysis) users. Extensive software support (many languages, numerous software libraries) and equipment requirements (central processor speed, large internal core sizes, or extensive external disk storage) are typical needs. A variety of levels of service may be required ranging from immediate results for some to a few days for other users.

Many of the problem solving programs are presently batch processed. With the development and availability of many pre-programmed application packages on time-sharing systems, for example, the Dartmouth College IMPRESS system (an interactive statistical analysis program designed for work on social science data bases), interactive problem solving will increase rapidly. Users from many fields will utilize the computer's capabilities without having to develop their own programs. This will increase the need for interactive-time-sharing facilities as well as libraries of specialized interactive programs.

Production Processing

A variety of computer services involve providing support to a production process. Examples include such things as payroll, student registration, student admissions, the production of learning through CAI courses, and a variety of testing and major research data collection and reduction applications. As previously mentioned, there is a grey area between problem solving and production, although in this area it is generally clear to the user whether what he is doing is "testing" a program (perhaps with voluminous data) or expecting a production run. The most important aspects of production processing are the generally rigid requirements from a timing and control standpoint.

The users of the computer in the production mode include the administrative and public service user, the researcher to a somewhat lesser degree, and to a slight degree the student.

The production user is typically interested completely and solely in the results of computing and very little in the process. He will generally prefer the level of service providing the least and most indirect exposure to the computer. Many researchers, for example, begin at a level of service at which they are in direct contact with the computer via their own batch programming or via terminals. However, as familiarity is gained, some researchers may become more like the administrator, desiring system and program design in order to obtain the effect they have specified. Many production users have a significant need for technical support in both the problem definition and the system design as well as programming phases. The administrative user requires additional service in the operational control of the integrity and timeliness of data bases.

As additional business practices are implemented, such as Programming, Planning, and Budgeting Systems (PPBS) and others being recommended in the Planning and Budgeting Manuals of this Management Improvement Program, the needs for production system design, development and processing will increase.

Statement of Users Future Needs

Having discussed the computing needs on campus in general, what remains is to discuss how the future needs of users can be established.

As with any organization providing service to a captive market, the satisfaction of users future needs can become self-fulfilling prophesies if care is not exercised. Thus, the users must be involved in ascertaining their future computing needs either independently or preferably after consultation with computer services. The failure to involve users in defining their future needs often results in excess resources in some areas and unfulfilled needs in others. The methods suggested for involving users in determining their future needs (formal meetings and user committees) are discussed below.

Institutional Goals and Objectives

Computer services goals must flow from the goals of the university itself. Ideally, the university should publish a statement of goals and objectives for the guidance of its management, staff and other interested parties. This requirement is being addressed in the accompanying Planning Manual of this Management Improvement Program. In the event that the goals and objectives are not documented, the computer services director must have verbal access to the chief executive officer (vice president or president) in order to obtain an explanation of university goals.

A number of specifics must be known in addition to access to the statement of goals and objectives.

- What are financial plans or problems of the university in the areas of capital funds? (Affects lease-buy decisions, facilities expansion or modernization)
- What is the size and availability of operating budgets? (Affects the scheduling of programs, training and travel of staff)
- What are plans for growth in areas requiring new computer services? (hospital expansion, general enrollment growth, research, new degree programs)

Issues Affecting Computer Services Goals and Objectives Formulation

In addition to establishing the institutional goals and objectives, the following issues must be addressed in deciding upon the goals and objectives for computer services:

1. Assessment of current status and the degree to which present user needs are being satisfied
2. Assessments of current strengths and weaknesses of computer services
3. Prediction of impact of technological, economic and physical changes in hardware, software, management techniques and personnel policies through forecasts.

Each of these issues are addressed below. In addition:

4. Assumptions regarding funds and other resources must be made.

Assessment of Current Status

A number of factors must be considered in determining the current status of computer services on campus. The major factors include:

- A complete inventory of equipment resources — type, location, age, accruals, educational allowance
- A complete inventory of software resources — application programs acquired, campus developed systems, vendor supplied software — purpose, availability, initial cost and recurring costs, last use and revision, responsible analyst and user, if appropriate
- A detailed statement of equipment and software capability and utilization — CPU usage, disk usage, tape usage, printer usage, and terminal usage — hours scheduled, metered and actually available on a monthly basis — inventory of programs, frequency of use and resources expended for maintenance — mix between instructional, research, public service, and administrative usage — percentage of computing for production, checkout, compilation and testing.
- A statement of last year's expenditures — operations, unit record, applications, systems analysis, administration, equipment (including reserve fund if purchased), software, maintenance, miscellaneous
- A summary of the past years evaluations by users through questionaires, meetings, suggestion boxes and polls.
- A personnel inventory — names, levels, educations, skills, previous experience
- A list of significant accomplishments — is there a lack of same, are there problems with users due to users lack of understanding or computer services deficiencies — where should corrective action be taken?

Strengths and Weaknesses

Based upon the assessment of current status, the strengths and weaknesses in a number of critical areas can be identified. It is advantageous to quantify as objectively as possible the strengths and weaknesses of the organization.

- Facilities and Equipment — adequacy of space, expandability of space, adequacy of CPU, disks, terminals, printers, core, software, etc.

- Software — Are user needs being met? Are programs in operational status? Are consultant services available for all programs? Does adequate documentation exist?
- Personnel — skills needs vs. skills available
- Management — How well do subordinate managers plan and control? How well are personnel developed, motivated, and informed? Are projects adequately planned and monitored?

The development of long-range plans requires the knowledge, or more precisely, the best estimate, of future technological, economic and physical changes. Upon investigation, many of the so-called technological breakthroughs will be found to have much smaller technical impact than the marketing literature would lead one to believe. However, the relationship between technological changes and a manufacturers marketing policies cannot be over-emphasized. During the planning process, managers should ask the following questions:

- What are hardware projections? Will cost of equipment decrease or will only cost per computation decrease? How should these factors affect buying, leasing, renting? What is outlook for third party acquisition and for continued vendor support for older models?
- What are software projections? Will software developments hasten centralization of campus wide data bases with update and inquiry capability through terminals? Will future operating systems features increase need for disk and drum storage? Will improved operating systems for time-sharing improve resource utilization thus reducing time-sharing cost considerably? Will availability of new languages increase need for computing power because of new users, and will new users require pre-programmed application packages requiring university development or acquisition?
- What are the effects of and trends in costs of core storage? Will decreasing core costs hasten interactive computing?
- What are the economies to be realized from services from other institutions or from commercial time-sharing firms. Will facilities management services become viable for universities?
- What effects will remote job entry stations and mini-computers have on centralization vs. decentralization of computing facilities?

Many of these technological estimates can be made by members of the staff who have the appropriate expertise. Lacking this, the journals, conferences, discussions with vendors and suppliers and with other university computer services directors, are methods of obtaining estimates of the future.

Forecasting Techniques

Good forecasting procedures are clearly essential in all aspects of planning, since the prediction and estimation of occurrences of future events provides a basic input into the planning process. The comparison of alternatives requires that the most likely future consequences be determined. The significance of forecasting in the planning process has resulted in researchers developing an exceptionally wide variety of techniques to assist the forecasting effort. These techniques are described in Appendix 2.1.

Methods of Formulating Goals and Objectives

Goals, once set forth, will guide all subsequent planning. Thus, their actual formulation involves decisions which only the top executives of computer services and the university can make. The role of staff assistants is to find devices which aid these decisions. Managers will recognize that the information which must be merged into direction — giving statements of goals can only be dealt with in a subjective way. Some of the methods available for this task include:

Intuitive Judgment

In this method, which requires little or no structuring of the task, the most experienced computer services personnel become thoroughly familiar with the background data (needs of users, availability of technology) and then ask, "What does this information tell us?" A computer advisory group or computer council is an excellent vehicle for gathering the executives together. Despite its appearance of simplicity, this method brings to bear the greatest experience and best judgment available and it is the one most often used.

Quantitative Rating and Ranking

Another method of formulating goals is to assign some kind of comparative values to the individual factors that must be combined and reconciled. It should be recognized that this is not a mathematical exercise in the conventional sense.

Users of this method of formulating goals should be aware that it is difficult to assign meaningful values to the kind of information involved. Moreover, making judgments in this piecemeal fashion can lead to large cumulative errors. An experienced director's intuitive grasp of the whole interplay of influences on goals may be a more precise way to determine accurate goals.

Creative Reasoning

This is the most subjective method of synthesizing information into statements of goals. It calls for a different kind of intellectual activity from the methods mentioned above. It emphasizes creative thinking rather than judgment born of experience. Here the question asked is, "What are the possible new ways in which this factor or combination of factors can be made to work to best total advantage?" Computer service planners on the university campus have a potentially powerful resource available to assist in this method. Members of the faculty may, through participation on computer committees or individually, be a vital asset in this method and should be consulted. Many universities have faculty members advising business firms on their computer services planning, etc., and these faculty should be brought into the universities' computer services planning process.

A number of other techniques have been advanced to assist in the formulation of goals. One technique involves brain-storming sessions of appropriate computer services management, users and university administration. An inventory of possible goals results from the sessions. Mini-Delphi type techniques can be used to converge toward the most appropriate goals for computer services.

Although goals of individual universities will differ, there is a common thread that relates to the instructional, public service and research activities of each university. In addition, since the institutions must operate as efficiently as any viable business, efficient administration forms a component of the institution's goals.

Examples of Goals for Computer Services

The following list of statements are examples of goals of computer services within a university.

1. To provide the computing services required for educating a sufficient number of persons about the computer to meet the societal needs for computer specialists, users and literates.
2. To improve efficiency in the use of the computer for instruction about and with the computer wherein it has been determined that the computer is the best medium.
3. To ensure that access to the computer and associated instructional materials is possible wherever its use is cost-effective.
4. To improve the cost-effectiveness of instruction with the computer where such improvement will lead to a consequent improvement in the cost-effectiveness of higher education.
5. To provide the most effective computing facilities for campus research **on** the computer, either as a part of the central center or as a separate facility.
6. To provide the necessary hardware and software for supporting the demonstrated needs of campus users employing the computer in their research.
7. To provide the administrative areas of the university those computer services necessary to implement modern practices of business administration including, for instance, optimizing the use of historical and current information that the institution deems necessary.
8. To provide computing services to administrative areas where expanded use of the technology will allow more efficient operation.
9. To assist the management of the university to make better decisions on the use of human and capital resources.

Expansion of a Typical Goal into Specific Objectives

The above goals must be expanded into specific objectives, that is, steps necessary to accomplish the goals, if they are to have utility. To illustrate the necessary detail, goal number 2 above will be expanded into four sample objectives.

Goal (Sample):

To improve efficiency in the use of the computer for instruction about and with the computer wherein it has been determined that the computer is the best medium.

Specific Objectives (Samples):

#1 To remove the leased small scale computer from the Electrical Engineering building and release it by Winter, 1975.

#2 To increase utilization of remote batch job entry stations in the Business, Chemistry and Engineering departments by 50% by Winter, 1975.

#3 To expand the number of interactive terminals around the campus to 24 by Fall, 1975. If prime time (8:00 a.m. to 10:00 p.m.) utilization does not reach 50% at any locations by Spring, 1975, remove terminal for future release.

#4 To reduce turnaround to 15 minutes maximum for 90% of student express batch jobs by Winter, 1975.

Estimating Program Resource Requirements

Since resources will always be limited, there will be a constant trade-off between the dollars and talent available on the one hand and the projects to be undertaken and the services to be provided on the other. This is a significant component of the planning process since the university administration may be more interested in the financial implications than in the technical content of programs. Thus, emphasis should be given here, and the details of the trade-offs involved in various alternatives clearly spelled out wherever possible. An example of such a trade-off is the statement, "If expansion is required in this administrative project with no increase in resources, the following instructional services must be curtailed."

The resources component of the plan should be expressed in **dollars, staff, equipment, software and facilities** requirements and be broken out according to program. The resources requirements should be projected quarterly or yearly depending upon the projection interval and available information. These projections will be a valuable tool to the computer services director especially in spotting future problem areas. In the facilities section the requirements should include the why and the when as well as an estimate of the cost.

Priority Assignments

The program and the required resources should be ranked with an assignment of priorities so that, in the event of changes in the financial or personnel situation, planning will not have to be repeated. As the plans are updated annually, the priorities must be altered as users' needs change. For example, some users, when not provided service they requested, may have acquired alternate solutions that they now prefer. Additionally, many times knowledge of resources gives a good indication of how priorities must be ranked.

Comparison of Alternatives

After goals and objectives are established, alternative courses of action should be devised which offer promise of fulfillment. Comparison of the alternatives is then necessary. After intensive evaluation, one or more of these is tentatively chosen as the strategy, i.e., the program to be pursued. Tests should then be applied to make sure the choice is a wise one. At the heart of this decision making should be the analysis technique known as cost-effectiveness or cost-benefit analysis.

Cost-Effectiveness Analysis

Cost-effectiveness analysis refers to a number of techniques for evaluating the effect of proposed changes in a system and on the expected costs of the system. The analysis measures the additional utility of a program change and compares it with the marginal cost of making the change, thus giving the planner a guide for choosing among alternate ways of achieving a particular objective.

Cost-effectiveness analysis is essentially the comparison of two or more alternatives with regard to their cost and effectiveness in performing some functions. There are actually four distinct criteria by which one of the alternatives could be judged superior in cost-effectiveness to the others.*

1. **Lower cost, equal effectiveness** — The superior alternative is less costly than the others but equally effective.
2. **Equal cost, higher effectiveness** — The superior alternative is no more costly than the others but is more effective.
3. **Higher cost, higher effectiveness** — The superior alternative is more costly but it is also more effective. The increase in effectiveness is judged to be worth at least the increased cost.
4. **Lower cost, lower effectiveness** — The superior alternative is less costly but it is also less effective. The cost saving is judged to at least compensate for the reduced effectiveness.

The criterion to be satisfied in a given analysis will depend on the objectives and constraints of the decision maker. If the budget is fixed, criterion 2 is appropriate. If it is important to save money, either criterion 1 or criterion 4 is appropriate with criteria 1 being desirable. If increased effectiveness is essential, criterion 2 or criterion 3 is appropriate.

The exhibit below illustrates a cost-effectiveness comparison.

Exhibit 2.1 Criteria for Cost-Effectiveness Analysis

Alternate	Cost*	Effectiveness*	Criterion from above by which alternate is more cost-effective
Current situation	10	10	—
Alternate A	9	10	1
Alternate B	10	15	2
Alternate C	15	20	3
Alternate D	5	9	4

* Cost and Effectiveness specified in some units

Another possible criterion that seldom arises is not illustrated in the exhibit. It is where costs could be reduced (eg., 5) and effectiveness increased eg., 15).

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* **Framework for Decision**, R. E. Levien, S. M. Barro from **The Emerging Technology**, R. E. Levien. A Carnegie Commission on Higher Education and Rand Corporation Study, 1972, McGraw Hill Book Company

Aside from the 5th criterion cited above, most university computer service decisions should be justified through one of the four criteria in Exhibit 2.1.

Possible Criteria

In an era of tight financing for higher education, resulting in reduced or "no increase" budgets from computer services criterion 1 or criterion 2 will often be applicable. Equal effectiveness for fewer dollars or slightly higher effectiveness for the same dollars are possibilities. If budget cuts are mandated, criterion 4 may be selected wherein the alternative that reduces effectiveness the least is superior. Where increased expenditures are possible from increased budgets or reallocations of funds criterion 3 should be used to determine the superior alternative.

Determining Cost and Effectiveness

In applying cost-effectiveness analysis care must be exercised in determining cost and effectiveness. Cost for computer use must include all applicable factors. Direct costs (hardware, software, staff, forms, supplies, communications, travel, etc.) as well as indirect costs (custodial services, space, management time, air conditioning, utilities, etc.) should be factored in. If a computer system is to be cost-saving, for example in an administrative area, the outlay for computer system must be more than offset by decreases in some or all of the other components that make up the institution's total budget. Cost determination, although requiring more effort than is currently in use, should not be a difficult task. This is addressed further in Chapter III.

Effectiveness determination, however, is not so easily accomplished. In the administrative areas improvements in effectiveness can usually be determined quite readily. In addition to taking advantage of the computer's superlative clerical abilities to perform faster and more efficiently those tasks previously done manually, the computer should be utilized to gather and process cost and other decision-making data previously unavailable.

In the instructional area, effectiveness is difficult to ascertain because of the basic problem of specifying the output measures in higher education. In addition, the lack of output measures for conventional instructional techniques is exceeded by the lack of measures for the new instructional techniques that utilize computer services. The task force recognizes the problem and suggests the following guideline regarding instructional effectiveness. Judgments regarding the relative effectiveness of computer instruction should be made by the faculty at the academic department level at each university. A judgment that computer instruction is superior or equal to conventional instruction is a subjective judgment that should be made locally.

Regarding the cost in the instructional area, the task force recommends that the universities devote more effort to establishing cost data on a course-by-course basis. This data will be needed much more in the future in making the decision regarding where on the campus computer instruction should be implemented. Computer costs can usually be quickly, although not always accurately, estimated by those who claim computer-assisted instruction and the like are too costly. For a valid comparison, the costs of the present teaching methods should be established before cost-effectiveness analysis can be utilized.

In many of the cost-effectiveness tradeoffs involved — more interactive terminals vs. more remote job entry stations, more core vs. faster CPU — the computer services organization must solicit the opinions of the various users. This is yet another instance that requires the planning process to be as participatory as possible and to reach as far down into the university structure as is practical. The users (students, faculty, researchers, administrators, outside users) must be involved in providing input to the tradeoffs as well as in the entire planning process to the extent that their contributions are meaningful.

Timing-Users Plan and Computer Services Plans

Computer services planning can best be accomplished after the preparation of plans by the user organizations. This would allow maximum visibility for the computer services planners and therefore result in the most efficient and effective strategies. Since this probably is not feasible at most universities, a balance must be found between computer services planning independent of its users and planning after all users have finalized their plans. Thus, the computer services planning must be iterative wherein during the first stage best estimates of user needs are made based upon present use and projected use. During the second stage the plans will be altered based upon input from users.

Interaction with Users During Planning

Because the needs of the campus computer services markets differ and because responsibility for the other organizations making up the markets falls outside computer services, planning must be a joint venture. There must be a useful dialogue between user and provider. This dialogue can occur through formal scheduled meetings with users, through consultation with users or through user committees.

Formal Meetings

One approach is to schedule discussions between user organizations (Chemistry Department, Business Department, Registrar, Financial Aids Office, etc.) and computer service management prior to and during the planning activity of the user organizations. Formal sessions between user groups and computer services at mutually agreeable times are more beneficial than simply having computer service personnel available for consultation at the pleasure of the user. The former requires an interaction while the latter only allows for it. Formal meetings force the user to contemplate his needs. To conserve time, each user organization should be contacted regarding the utility of a formal meeting. Benefits are derived since the computer service personnel are aware of the latest equipment and techniques available as well as related applications used elsewhere. During these sessions computer services' role is merely advisory. The responsibility for the planning process remains within the user organization. These sessions allow the user organizations to obtain estimates of the technical feasibility and the associated costs of various strategies. In addition, the computer services personnel have the opportunity to familiarize themselves with the users' work and suggest alternate approaches that are presently available or are expected to be within the planning period. The user is thus brought abreast of the state-of-the-art in a manner most useful to him specifically, the manner in which the advancing state-of-the-art affects his needs.

As a result of the discussions between users and computer service staffs, the users (departments, offices, etc.) should develop a computer resource section of their organizational plan much as they do the personnel component. This section should include estimates of capacity/time/cost requirements for software development and hardware.

In order to accomplish the above user-driven type of planning, **the Task Force makes the following recommendations:**

1. **University management require that all offices preparing a five-year plan include a computer services component.**
2. **In addition, at a given time each year all academic and administrative offices submit to computer services, a written plan in as much detail as is known, concerning their computing needs and plans for the following two years.**
3. **Computer services interprets the above plans, assesses the operational and technical feasibility, estimates the resources necessary to achieve the stated objectives, and constructs a university-wide computer services long-range plan.**
4. **The budget development for computer services follows from the university-wide computer services plan with the determination of priorities accomplished at a level above computer services management.**

Committees for Planning

Many institutions involve one or more committees or councils as another method of integrating user needs into computer services planning. Committees help to resolve conflicts between users' needs and ascertain the feasibility of servicing differing needs. A guideline to be followed is that committee members should represent all users. No user should lack a clear line of communication to his representative.

Top administration should be represented on a policy level committee so that the needs of the users will be known when institution budget decisions are being made and, perhaps more importantly, that decisions reached by the committees will carry sufficient weight for implementation.

Content of User's Long Range Plan for Computer Services

Each long-range plan for computer services generated by user organizations should list the specific programs and a general description of the programs that the user organization wants to implement over the time frame of the plan. The description should include:

- Process explanation

- Equipment necessary for implementation
- Data required, source and authorization
- Report formats, if known
- Program milestones
- Similar system(s) in use at other institutions
- Summary of tasks to be performed

The plan document should be generated by the user organization after discussions regarding feasibility, duplication and cost are held with the computer services management.

Responsibility for Developing Plan

The overall responsibility of planning computer services must lie with the computer services director. At each phase of the process, such as establishing goals and objectives, he should consult with his principal subordinates to gather their opinions. At each critical phase (establishing goals and objectives, for example) the director should also try to obtain the approval of the administration so that planning does not proceed too far on invalid assumptions.

Many of the responsibilities can be delegated to subordinates, for example:

- Assessment of Current Status
- Technological Forecasts
- Detailed Planning in Support of Goals and Policies

The subordinates should be encouraged to include participation of as many of the computer services staff as feasible on the various phases. This will increase motivation, inform the staff regarding future directions and the reasons, and in some cases, will elicit opinions not previously considered. As mentioned a number of times above, the participation of the users is a necessity.

Responsibilities for Review

The computer services director should include as the last step in the process, a detailed check to ensure that the plan is consistent. Are the schedules such that they coincide with and complement each other? Do the programs ensure that they support the goals and objectives of the consumer services organization as well as the university goals and objectives?

Components of Plan

As mentioned above, the plan that results from the planning process should be a complete documentation of the process. As such, it should include:

- The goals and objectives considered and adopted
- The different activities and programs postulated and recommended
- The cost-effectiveness analysis employed and the assumptions used
- The recommended programs including budgets, schedules, and milestones
- The criteria to be measured for progress verification

In addition, the plan should be structured to include a number of subplans or components of the plan.

- Hardware schedule — time-phasing of hardware changes

- Software schedule — compilers, data base development
- Personnel development plan — training, conferences
- Financial plan — dollar and facility requirements
- Physical facility plan — timing and resource requirements
- Detailed project plans — applications development
- Short-range plan — one-year operating plan

The one-year operating plan should contain sufficient detail so that additional short-range planning is minimized. The one-year operating plan component should be updated periodically without the need to update the long-range plan on a more than yearly basis. In addition, the milestones in the one-year operating plans should occur at intervals that assure tight control to eliminate efforts in the wrong direction. **The minimum and maximum number of milestones in any plan should be governed by this rule: the number should be such that the missing of any one milestone does not jeapordize the plan or the ultimate objectives.**

3. Financial Implications of Computer Services

Overview

The financial implications of computer services are indeed important. The costs for computer services are growing faster than most other costs in higher education nationally. This fact taken alone can be, of course, misleading. It can be successfully argued that a large proportion of the computer services budget increases result in additional exposure and experiences for students truly necessary in today's society. This applies obviously to the student intent on a career in computer applications, but also to all other students whose lives and careers will most certainly be affected by computers. Applications of the computer to the business problems and decision making on the campus can also justify a good portion of the budget increases. In summary then, more is being spent on computing on campus but much more is, or at least can be, accomplished because of computers.

This chapter addresses the issues of the amount of resources being expended for computer services, on a per student basis and as a percentage of operating funds. It also addresses the percentage of computer services resources devoted to equipment and the distribution of computer services among instruction, research and administration. The topics of cost saving suggestions and rental purchase guidelines are included as well as allocation of costs back to users.

Level of Computer Service Dollars

As part of this Management Improvement Program the Computer Services Task Force Members reported certain computer services dollar amounts for their universities. To make the meaning of the values as consistent as possible some guidelines were specified for reporting. The amounts reported for personnel were to include dollars spent for fringe benefits but not other general overhead. For equipment that was purchased rather than leased or rented, the equivalent rental figures (defined as the presently available rental rate less the educational allowance available the year the equipment was purchased) were to be included. Therefore, the amounts reported are not exact budget values nor exact expenditures.

The twelve public universities in Ohio reported $4.8 million for computer equipment in 1968/1969. The total reported computer services dollars for the twelve schools totaled $10.2 million during the years 1968/1969 when the Warren King Report was prepared. Warren King had incorrectly reported these data as $4.3 and $9.0 million respectively.

FINANCIAL IMPLICATIONS OF COMPUTER SERVICES

During the academic year 1971-72 the reported amounts were $8.8 million for equipment rental and $17.9 million for total operating dollars. It is interesting to note that the Warren King firm had estimated that it would take four or five years for computer expenditures to double. In three years time the equipment and total computer services dollars have nearly doubled.

Exhibit 3.1 contains the equipment dollars, the percent of the total these dollars represent and the total computer services dollars for the twelve public universities for the years 1968-69 and 1971-72.

	1968/1969			1971/1972		
	Equipment		Total Computer Services	Equipment		Total Computer Services
University	($000)	Equipment as % of Total	($000)	($000)	Equipment as % of Total	($000)
Bowling Green	220	41	540	480	45	1,056
Central State	30	33	92	38	42	91
Cleveland State	150	54	276	360	47	774
Kent State	263	38	701	539	44	1,216
Miami	242	47	520	312	40	776
Ohio State	1,999	53	3,802	3,750	57	6,630
Ohio	387	36	1,075	563	45	1,260
Wright State	47	29	160	270	49	556
Akron	341	40	843	555	41	1,358
Cincinnati	672	48	1,401	1,195	45	2,676
Toledo	97	43	227	358	43	831
Youngstown	233	57	405	449	58	774
TOTAL	4,681	46	10,042	8,869	49	17,998

EXHIBIT 3.1 — COMPUTING EQUIPMENT AND TOTAL COMPUTER SERVICES DOLLARS

NOTE 1—The dollar amounts include:

a. fringe benefits but not other general overhead

b. an "equivalent" rental payment figure for purchased equipment arrived at by taking the manufacturers present rental rate less the educational allowance available the year the equipment was purchased.

NOTE 2—The 1968/1969 figures are the dollars reported by Warren King in its report. In five cases these values were inaccurate and have been corrected by the Task Force representatives.

Regarding levels of expenditures it would be helpful if there existed a set of norms by which a university could judge its decisions regarding allocation of resources to computing. Unfortunately, as might be expected, norms that do exist are general and do not cover the situation at many institutions. Rather they are averages of schools throughout the nation.

A guideline often quoted regarding computer expenditures in Higher Education was recommended by the President's Science Advisory Committee (PSAC) in its report, "Computers in Higher Education," published in 1967. The PSAC report estimated that by 1971-1972 the expenditures for instructional computing for undergraduates should be about $60 per year per student averaged over all college students. The committee indicated that the average of $60 per year should provide for adequate educational use of computers in colleges and universities (exclusive of graduate research). The panel based this estimate on the use of large time-sharing computer centers and included the cost of terminals, communications and operation of the centers. For the $60 per student per year the President's Committee estimated that all colleges and universities could be provided a level of computer service equivalent to a relatively advanced school in the time period 1965-66 (e.g. Dartmouth College).

Computing Dollars Per Student

Exhibit 3.2 is a tabulation of the reported per student dollars for the years 1968-69 and 1971-72 subdivided according to instruction, administrative data processing and research. It should be noted that all of the schools

EXHIBIT 3.2 DISTRIBUTION OF PER STUDENT (HEADCOUNT) COMPUTER SERVICES DOLLARS

	1968-1969				1971-1972			
University	Instruction	Administration	Research	Total	Instruction	Administration	Research	Total
Bowling Green	**	**	**	38	11	45	7	63
Central State	*	*	*	33	*	*	*	37
Cleveland State	*	*	*	27	*	*	*	52
Kent State	2	17	7	26	6	26	10	42
Miami	**	**	**	36	**	**	**	45
Ohio State	26	21	21	68	48	26	25	99
Ohio	3	36	9	48	4	38	10	52
Wright State	7	14	1	22	9	33	2	44
Akron	9	50	0	59	32	36	0	68
Cincinnati	7	26	16	49	16	31	31	78
Toledo	6	7	3	16	17	30	10	57
Youngstown	**	**	**	29	18	31	4	53

Notes: * Data not reported

** Data not obtainable from records

Total does not include All Dollars (e.g. Public Service) are below the average recommended by the President's Science Advisory Committee of $60 per student per year for **instructional** purposes. This is in keeping with national statistics as indicated below.

	National Cost/Student
Instruction	$19
Administration	21
Research	20
	$60

The estimated distribution of nationwide expenditures for instruction, research, and administrative data processing in 1969-70 was:

Instruction	30%
Administration	34%
Research	32%

These data were reported by John Hamblin in the **Inventory of Computers in Higher Education,** 1967-70, **Utilization and Related Degree Programs.** The Ohio figures indicate that many of the schools have devoted substantially more computing resources to administrative rather than academic purposes. Many schools across the nation have found, however, that when computing resources are made available for academic purposes the latent demand for services usually surfaces very rapidly. A case in point exists within Ohio where the University of Toledo Community Technical Campus' academic usage of the Northwest Ohio University Computer Center has increased substantially as compared to the prior usage of the Community Technical Computer Center. A similar situation also occurred in the Southwestern Ohio Regional Computer Center.

The prior low academic usage, one can conclude, is due more to a scarcity of computing resources rather than the lack of user needs. It may also be due in part to a lack of knowledge on the part of academic users of the available computer service resources. If this is the case on a particular campus, the director of computer services is urged to devote part of his efforts to educating the academic users concerning the existence and capabilities of the computing resources available. The PSAC in 1967 addressed this problem by stating, "Expansion of educational use of computing depends heavily upon increased knowledge of computing by faculty in most disciplines. Such knowledge usually can be provided by intensive 2-6 week periods of faculty education."

The high administrative dollar per student amounts at many of the universities leads one to seek methods of achieving more efficient operation. Many universities nationwide are aware of the problem and national efforts such as CAUSE have as a purpose the lowering of ADP costs through the exchange of application packages rather than the self-generation of each system with the attendant costly necessity for program maintenance. Inter-institutional cooperation in the administrative data processing area, one of the possible solutions to the problem, is addressed in a later section of this chapter.

Relationship of Computer Dollars to University Income

Allocation of Resources to Computer Services

Another rule of thumb sometimes quoted regarding university computing was reported in the Proceedings of the EDUCOM Spring, 1971 Conference on "The Financing and Organization of Computing in Higher Education: 1971." There it was reported that the computing center budgets for sixteen selected universities represented from under 1 percent to almost 4 percent of the total university expenditures for operations. Exhibit 3.3 indicates the percentage of university operating budgets devoted to computing for the public universities of Ohio.

The data in Exhibit 3.3 is included to assist university administrators in determining how their universities' allocation of resources to computing compares with other public universities in Ohio.

EXHIBIT 3.3 COMPUTER SERVICE DOLLARS AS A PERCENTAGE OF UNIVERSITY CURRENT GENERAL INCOME

University	1968-69	Current General I/C (000's)	1971-72	Current General I/C (000's)
Bowling Green	1.60%	$ 33,317	2.27%	$ 46,386
Central State	1.37	6,673	0.88	10,259
Cleveland State	2.02	13,623	3.11	24,853
Kent State	1.39	50,122	1.88	64,491
Miami	1.74	29,831	1.90	40,651
Ohio State	2.02	187,467	2.60	254,474
Ohio	2.15	49,984	2.05	61,237
Wright State	2.17	7,344	2.99	18,580
Akron	4.10	20,535	3.91	34,721
Cincinnati	1.82	76,945	2.29	116,850
Toledo	1.20	18,911	2.80	29,642
Youngstown	2.45	16,513	3.58	21,598
STATEWIDE	1.96%	$511,265	2.49%	$723,742

Determining/Reporting/Allocating Computer Services Costs

The acquisition of a computer is not a one-time expense even when the computer has been purchased. Programming and operations staff, maintenance and supplies are recurring expenses. If the computer has been purchased, there is also a depreciation expense since the computer will need to be replaced in a number of years. Issues arise regarding how these expenses should be determined and reported, and whether the university should financially support computer services as overhead or have individual users share in the expense in some proportion to their use. This section addresses these issues.

Effect of Computer Services Organization Growth

Initially when a computer services organization supports only a few departments and performs a limited number of tasks, cost determination, reporting or allocation is not a problem. In this case there may be excess time available on the computer and the staff of the organization may have the time available to support all user requests for service. As enrollments increase and/or the use of the computer expands on campuses, a new situation will develop. As the usage of the services expands and the organization takes on more duties, there comes a point where additional organizations begin competing for the service. In an economic sense the computing resource (equipment and/or personnel) has become scarce.

Following the theory of economics, some method must be found to ration the scarce resource. The methods that are used to ration can be classified under the general term price, where the price to be paid to obtain service does not include only money but also other items such as time or inconvenience. Rationing can be on a "first-come-first-served basis," "all administrative data processing at night," "debugging before production runs," etc. When the computer resource has grown to a significant portion of the institution's total resources and still remains scarce, the point is reached where it is advisable to have user's share the cost of the resource in relation to their use (allocation of cost). Long before this point is reached however, university management should be kept aware of the utilization of computer services, who the users are and what their use amounts to in dollars and cents (determination and reporting of cost). Exhibit 3.4 illustrates the three levels involved.

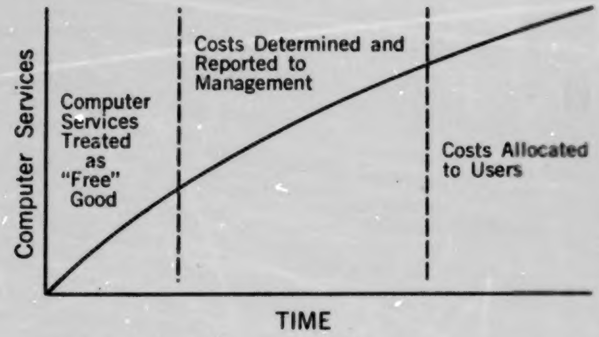


EXHIBIT 3.4 GROWTH OF COMPUTER SERVICES

"Free" Good Approach

Most higher education computer centers initially treat computer services as a "free" good in much the same manner as the library is treated as a "free" good. Proponents of this library analogy argue that, even as usage grows, the users should not have to be concerned with the cost of the services he uses. This is, they argue, how it is in the library. However, the library analogy does not hold true since the incremental cost of one library user is beneath the level of notice, whereas one user of the computer can monopolize significant resources, at the expense and inconvenience of other users. If the growth of computer usage is to be in line with what is necessary for educational purposes the user should have some reminders of the value and scarcity of the computer services resources available to him. These reminders minimize user attempts to monopolize as much of the equipment as possible, as well as encourage users to attempt alternate, less expensive methods of data processing that may be more cost-effective.

Additionally, in an era when tight financial situations require difficult decisions to be made on campus, cost information is a necessity. Costs must be known for each campus program as well as for the contributing factors to each program if valid decisions are to be made. As the Carnegie Commission has recommended, "When a college or university launches a move toward more effective use of its resources, no step is more important than a careful analysis of costs . . . there is little incentive to save on what are 'free' goods."

Pricing Policy

Once costs of providing computer services are determined, a pricing policy must be established. Price is what users are charged for the service while cost represents what the provision of the service consumes in college resources. The difference between price and cost is profit or surplus. It may happen that in order to stimulate utilization of certain resources or services price is set below cost (a negative surplus) on certain equipment or services. In other situations a positive surplus may be desirable. Having touched upon the concepts of costs and prices, the remaining sections of this manual will treat them alike. That is, a zero surplus or profit situation in the computer center will be assumed.

Realistic and Equitable

The critical factors in determining and reporting costs are that realistic and equitable pricing policies be employed and that reporting of utilization and costs be as current as possible.

Realistic pricing policies include:

1. recover all costs (direct plus indirect) plus surplus if desired.
2. provide user control over the cost of jobs (user selects resources to be used)

Equitable pricing policies include:

1. provide reproducible charges (consistent charge for same job)
2. provide different charges for different resources
3. provide for user selection of turnaround (charge for fast turnaround)

Reporting of utilization and associated costs must be as current as possible so that the users and those responsible for users can take appropriate action as needed.

The bases on which cost is determined (e.g. how is overhead allocated?; how is computer time measured?) and then charged should be made public so that users can not only know the cost as the computer center measures it but can also make their own estimates.

Determination and Reporting Cost and Utilization—Recommendations and Benefits

The Task Force recommends that the universities develop and use accounting procedures which accurately measure the cost and utilization of computer services. The Task Force also recommends that users of the computer center be assigned user numbers and monthly utilization statistics and total (direct plus indirect) costs be provided to each major account.

The benefits of computer services cost determination and reporting are that both the users and management can make better decisions. Each is made aware of the amount of institutional resources that are being used to accomplish the task being attempted. The cost of lengthy computations or lengthy series of elementary operations or services in various fields should at all times be clear to the researcher, educator and administrator.

Costs — Direct and Indirect

The direct costs should include factors such as:

- hardware rental
- software rental
- staff compensation
- communications
- travel
- forms
- supplies
- depreciation (if applicable)

The indirect costs should include:

- space
- environmental control
- custodial services
- other appropriate sources of overhead

Methods for Determining Pricing Policies

A number of philosophies can govern how computer prices for various users are determined. As previously mentioned the guidelines should be policies that are realistic and equitable.

The simplist is not to calculate a monetary charge but rather to determine the usage of the computer on some utilization basis (i.e., CPU hours). This determination of utilization on the basis of time has been used at some universities. However, it is not sufficient since the units involved must be transformed into dollars before cost/benefit decisions can be made by, for example, department heads.

Another approach is to divide total computer services expenditures by estimated hours of usage to obtain a working dollars per hour rate. (Since estimated use will be inaccurate, the rate, and therefore expense, to each cost center will have to be recalculated at the end of the accounting period.) This approach is simple to implement but it has two drawbacks. If the mix of jobs is such that some utilize I/O, disk, and tape resources significantly, while others utilize primarily CPU power, a fixed hourly rate may be discriminatory. In addition, if other than a batch job environment exists, a fixed hourly rate that charges time sharing users the same as batch users is not equitable, since time sharing requires more expenditure of resources.

Pricing Algorithm with Priority Factor

A third approach to price determination that minimizes the above problem involves two aspects. First, a system is developed that establishes a basic charge for all the significant computer service resources that users may employ.

An example algorithm is included below. The algorithm is included as a simple illustration of what might be useful as a model to be varied depending upon institutional needs.

$$\text{Basic Charge} = \left[\text{CPU} + \left(\frac{\text{core}}{\text{32K}}\right)^{1.25} \times \frac{\text{core minutes used}}{5} + \frac{\text{cards read}}{250} + \frac{\text{lines printed}}{500} + \frac{\text{cards punched}}{100}\right] \text{dollars}$$

where

CPU	Central Processor Unit time in minutes
CORE	Core storage used
Minutes used	Time that core storage is in use in minutes

Secondly, a factor (sometimes called priority factor or category of service) is used to increase or decrease the charge for service as a function of the responsiveness of service (e.g., immediate turnaround, overnight, timesharing, etc.) This is a multiplier such as

Standard Service	1.0
Overnight	0.5
Immediate	3.0
Time Sharing	2.0
Idle	0.1

that is multiplied by the Basic Charge resulting in a net charge for individual users.

As an example using above basic charge formula weighted with priority, if a job used one minute of CPU time, used 32K of core for five minutes, read 250 cards and printed 500 lines, the charge would be \$4.00 for standard service and \$2.00 for overnight service.

The above example algorithm can be expanded to includes charges for

- Disk usage and operations,
- Tape usage and operations,
- Tape/Disk mounts,
- Form/Train Changes,
- Submit (overhead) charge,
- Logical Disk Mounts,

and other appropriate services. The charging system need not be an algorithm but could as well be a unit charge for each computer services operation (i.e., cards punched @ \$.005, etc.).

An example of the billing system developed at the University of Cincinnati is included for illustrative purposes in Appendix 3.1. The appendix contains the rationale that was used at Cincinnati to determine the cost of each computer service operation as well as how to distribute the costs to each user as equitably as possible. Appendix 3.2 is a similar billing system developed at The Ohio State University Systems Computer Center.

Recommendation and Benefits

The Task Force recommends that universities include in the charging algorithm a computing priority factor taking into account both the cost of various types of service as well as the institutional objectives regarding expansion or contracting of various types of service.

The benefits of including a priority factor in the charging system are that differentials that result can be used to distribute workload and hence achieve higher utilization of the hardware. Under a pricing system employing a priority factor, heavy users would increase their work at night and weekends in order to reduce their cost. This would result in better service and reduced costs to other users. The university may also use the priority factor in order to expand certain types of services it feels will benefit the users. For example, a low priority factor of 0.4 could be used to increase utilization of a batch monitor express system.

Cost Allocation

When computer service costs are determined for each campus user, the logical next question is, "Should costs be allocated to those departments utilizing computer services?"

Advantages

The arguments for cost allocation are that the resources being utilized by way of computer services should appear on departmental and/or program budgets so that management can be aware of how effectively its resources are being utilized. Costs are a necessary ingredient for cost/effectiveness analyses and cost comparison studies. In all likelihood studies such as these will increase in the future as institutions implement the systems, or at least the techniques, of planning, programming, budgeting systems or other planning and control systems.

In addition, with allocation of costs the user can decide for himself whether certain tasks are worth doing. The user also has a stake in improving the efficiency of service.

Disadvantages

The primary arguments against cost charge-back to departments is that it works against a policy that may exist on campus for growth in the utilization of computers. This is a valid argument and is appropriate for some schools which may still be in the infancy of computing. The financial controls to support the budgetary system may not be worth the effort if the computing resources are small. This situation is not the case for Ohio's public universities however.

It should be noted, also, that growth of computing can be provided for under a charge-back system. Departmental budgets for computing can be increased each year. To minimize the problem of users requiring service and having no funds, a portion of the computing budget can be held back at the vice-presidential level, for example. This would ensure the necessary computing funds for those instructional or administrative departments that estimated incorrectly.

Recommendation and Benefits

As suggested in Exhibit 3.4 there is a time in the growth of the computer center when it becomes advantageous to install a cost allocation procedure.

The procedure would involve having each university cost center budget for computer services for the next budget cycle. What constitutes a cost center (department, program, office of a V.P., etc.) should be determined at the institutional level. Some institutions may choose cost centers to be other than departments based upon application, use or other criteria. The budget would be developed by the departments and/or programs after each department has consulted with the computer services organization. This development would occur during the planning process as described in Chapter II. The funds reflected in the department budgets for computer services would be restricted to computer services and could be further restricted to the university's own computer center. This latter approach would guarantee that funds for computing would go toward expanding the on-campus organization whereas not requiring the funds to be restricted might result in making the college computer center become more competitive.

Having the individual campus cost centers budget for computer services would increase the likelihood that computer services planning would be user-driven, which is beneficial. The computer services budget would be related to, but not merely the sum of, the levels of services needed by the campus cost centers as reflected in their computer service budgts.

Since growth of computer services is still consistent with chargeback and since chargeback is a powerful tool in controlling computer services resource consumption and avoiding unnecessarily costly efforts the **Task Force recommends that universities institute a policy whereby individual campus cost centers budget for computer services and that these budgeted funds be restricted for computer services. The Task Force feels that it is frequently advantageous to restrict these funds to the campus computer center but that this determination should be made locally.**

Cost Saving Suggestions

Much of the thrust of this and any management improvement manual should be to reduce costs wherever practical. In this section are listed a number of specific areas that could lead to additional cost savings:

1. Purchase credits on equipment
2. Use of students as part time employees
3. Multi-vendor equipment acquisition
4. Lease or purchase of equipment from third party sources
5. Competitive bidding
6. Inter-institutional development of ADP packages
7. Use of off-campus facilities for specialized computing needs
8. Providing services to public and private colleges for a fee.

Purchase Option Credits

Most manufacturers include a purchase option as part of their standard rental contracts. A percentage of the rental payments for a specified time interval is used as credit if the equipment is subsequently purchased. Typically, the equipment must have been under continuous rental by the customer. Within Ohio some vendors treat all the colleges and universities under authority of the Board of Regents as a single customer in applying the purchase credits even though the equipment may be transferred from one institution to another.

For example, one vendor's present policy is to allow 50% of the first two years of rental payments (approximately 25% of list price) to apply toward eventual purchase (Purchase Credit policy). Because of the single customer account, one university or college may purchase equipment from the vendor that had been previously rented by another institution with the maximum savings being near 25%. This has been done by a number of the universities in the past and recently by some of the two-year colleges. The practice is particularly attractive if the rental equipment has a large Educational Allowance (20, 30 or 40%) which had been customary in the past.

A use of the purchase option credit among the Ohio public universities was utilized in the purchase of an IBM 360/75 system by Bowling Green State University resulting in an annual cost avoidance of $113,000 as well as in the purchase of an IBM 360/65 system by Wright State University for $84,000 less than the list price. The 360/75 system had previously been leased by The Ohio State University while the 360/65 system had been leased by the University of Cincinnati.

Lorain Community College recently acquired a 360/40 system from IBM for $80,000 less than list price after this system had been leased by the University of Toledo.

A variation that demonstrates the utility of the purchase credits in Ohio recently occurred between the University of Toledo and Michael J. Owens Technical College. Owens was in the market for two pieces of IBM input-output equipment that had an IBM combined list price near $75,000. The price from a third party for the IBM equipment was about $55,000. Toledo had been renting both units from IBM and the purchase price was $42,000, the purchase credits being fully accrued. An arrangement was made between Toledo, Owens, and the Board of Regents whereby:

1. The University of Toledo purchased the equipment from IBM.
2. The Board of Regents then approved Owens College's purchase of the equipment from Toledo for Toledo's cost plus an amount to cover Toledo's additional rental payments over the expected rental period.
3. The University of Toledo then rented the same type of units from IBM

The additional rental payments were a result of the fact that the older units had a 20% educational allowance whereas the new unit had only 10%.

In this situation, approximately $13,000 was saved directly by Owens College and indirectly by the State of Ohio.

Other variations of this application of vendor purchase credits combined with higher-than-present educational allowances are possible and it is recommended that they be considered by the institutions.

To facilitate this, **it is recommended that a system be set up through which information concerning potential release, acquisition or sale of equipment can be collected and disseminated by a central agency.** If the activity is justified, a monthly notice could be sent to all institutions notifying them of the equipment from each manufacturer that is entering, leaving, or being transferred within the state. The IUC/ADP is a logical central agency since such an activity has already been initiated.

Use of Students as Part Time Employees

A number of the students at the universities should be both capable and desirous of part-time positions in I/O control, keypunching, operations, applications type programming or program modification. Attempts at some institutions within Ohio and nationwide have had favorable results. A guideline to be followed is that individuals are selected who have a real interest in being part of the application of computer technology and also seem to be rapid learners.

There are a number of problems associated with this approach. A training program is typically required for some positions and this is time consuming. For the advanced positions such as maintenance and application programming, only the exceptionally fast learners may be productive. A potential problem exists in that students can alter programs (e.g., payroll).

The benefits include substantial savings including the savings in fringe benefits that is an expense for full-time employees. Additionally, the more successful student employees can be selected and offered positions on a full-time basis after graduation. The students also benefit in that many prefer this type of work as opposed to non-profession related part-time positions. The students can learn, earn and gain valuable job-related experience.

Multivendor Equipment Systems

It may be sound economically to explore the possibility of buying the various components of a computer system from more than a single vendor. There are a number of firms that offer, for example, peripheral devices that are compatible (so called plug-to-plug compatibility) with the major manufacturers CPU. The lease or purchase cost differentials for these disk drives, tape drives, add-on core storage, etc. are typically a significant cost savings area. The devices may also offer additional appeal from the capability standpoint. One of the trade-offs that must be made for the potential cost savings and/or performance improvements is the complexity of the decision-making in evaluating multi-vendor proposals on a component rather than a systems basis. Additionally, problems may arise in finding the faulty component when problems develop within the system. Different vendors may accuse each others' equipment of causing the problem and the computer services director must exert pressure to have the equipment returned to the operable status. With these problems taken into consideration, many institutions in Ohio and elsewhere have justified the approach on the increased cost savings achievable. With smart shopping the university may be able to obtain competitive or better performing equipment at a lower price. The institution must assure that adequate vendor support and service is available for its geographical area.

Third Party Sources

New computing equipment can, of course, be leased or purchased from companies other than the original manufacturer. On a piece of equipment from an original equipment manufacturer the monthly rental payments may be based upon a pay-off period of, for example, four years. A third party leasing company may purchase the equipment from the manufacturer and lease it to a university at a lower (10 to 15%) monthly rate. The leasing company uses a longer pay-off period, with resulting lower monthly payments, under the assumption that the useful life exceeds four years. Support and maintenance are still available for the system from the manufacturer. Usually the third party firm will require that the school enter into a fixed-term lease to assure the firm's profit margin. In considering this approach a school must balance the cost savings against the assistance that a manufacturer provides to his clients in terms of specialized support services.

Used computer equipment is also available for purchase or lease from third party companies. Equipment at substantial savings can be found, but care must be exercised that the particular model or configuration quoted is, in fact, available when the contract is to be signed. The third party used equipment market is very volatile and bargains depend upon the marketplace as well as the schedules of present owners for releasing equipment.

Competitive Bidding

Talking to a single salesman simplifies the decision-making regarding new or additional equipment. It is also an expensive luxury that should not occur. There are, in almost all cases, multiple vendors who have equipment that can support the needs of the university computer services facility. Additionally, as public agencies, state universities have the responsibility to provide the opportunity to all qualified bidders to supply computer services equipment and software.

The university should have a policy that requires the preparation of a formal Request for Proposal (RFP) and its dissemination to all interested and qualified firms for major computer services purchases, leases or rentals. The responses should be evaluated and a decision made regarding which vendor or combination of vendors best satisfies the needs. In the event the school does not have the expertise and/or staff time to evaluate the proposals and participate in the negotiations, a consultant can be hired for the effort or advice from other institutions can be solicited.

The RFP should indicate the needs of the university and should address at least the following points:

1. Hardware Requirements
2. Software Requirements
3. Benchmark Programs That Will Be Run
4. System Support Services
5. Conversion Costs

The evaluation process, including the assumptions employed, should then be documented including all of the significant conclusions.

Due to the effort involved in the preparation of a good RFP and associated benchmark program, the effort involving the director and senior staff in communications with interested vendors before and during the response period, and the effort involved in the evaluations and selection, an RFP can be both a time-consuming and a resource-consuming process. On the other hand, it does force the organization toward better planning and determination of needs and alternatives and, on balance, is a desirable practice for major purchases, leases or rentals of new or upgraded equipment or software.

Inter-Institutional Development of ADP Systems

A significant area of cost savings potentially exists within the design and development of Administrative Data Processing (ADP) programs and systems. It is generally recognized that at many schools the development and maintenance of ADP systems represents a good portion of the staff and computer time. Cooperative efforts in joint development are a potentially rewarding area.

In Ohio administrative computing utilization exceeds instruction and research computing at most campuses. In addition, there is a large and continuing investment in ADP applications program development and maintenance. A number of suggestions have been made in Ohio and throughout the nation for cooperative development and maintenance or exchange of ADP systems that are for application areas common to many universities. Although the call for cooperative efforts in order to minimize redundancy, duplication of effort and "reinventing the wheel" seem to make good theoretical sense most times little productive output can be observed. Exceptions do exist as was the case within Ohio where The Ohio State University adapted the University of Illinois student scheduling system thereby saving a substantial number of people years.

A recent study concerning the potentials and the problems was conducted by the senior universities in Illinois and their findings are summarized in Appendix 3.3. In order to investigate the problems and benefits from inter-institutional cooperation in the ADP area within Ohio **the Task Force makes the following recommendation.**

ADP Systems Recommendation

A committee of university computer services personnel directly involved with university administrative data processing be organized. The committee be managed by a working group composed of interested members of the committee. The committee will accomplish the following:

1. Develop a uniform set of documentation standards principally oriented toward facilitating the exchange of administrative systems.
2. Using the above documentation standards, develop an inventory of presently used administrative data processing systems within the universities.
3. Share and publicize systems developed or acquired by one institution that would be appropriate for other institutions.

4. Seek to develop systems in common when the requirements can be made similar enough at various institutions.
5. Act as an advisory body to the Board of Regents with regard to the Uniform Information System (UIS), modification thereto, and development or acquisition of like information systems.

Since the presently existing Inter-University Council (IUC) subgroup on Administrative Data Processing is a reasonable vehicle for accomplishing the above five tasks a new committee may not need to be formed. Each institution should, however, actively participate in the IUC efforts regarding the above.

Offcampus Facilities for Specialized Needs

Other university computer centers, regional computer centers or commercial service bureaus provide service that, while it may be required or desired by users at a particular university, cannot be cost justified on campus. This might include interactive processing for student or faculty use, specialized libraries or application packages. The use of these university or commercial facilities having the necessary capabilities may be cost effective if the alternative is to expand the on-campus hardware or software at substantial cost. Careful shopping can often times, because of various circumstances, result in exceptionally reasonable service for short periods of time as well as more cost effective service for longer periods of time.

Providing Services to Public and Private Colleges and Universities for a Fee

The topic of Inter-Institutional cooperation is addressed in Chapter VI and will not be examined here. It suffices here to state that the larger university computer centers, as well as regional centers formed by universities, should pursue the provision of remote service to the small public and private colleges in their vicinity. As the President's Science Advisory Committee stated back in 1967 it would be practical for well-run university computer centers to give adequate remote service to a considerable number of other colleges and universities in their geographical area. The Task Force believes that this is also valid today. The external income will help to offset the universities fixed costs as well as provide more economical service to the external institutions because of scale economies.

A guideline should be that the charges must reflect the actual resources (personnel as well as equipment) that must be consumed in marketing and delivering the service or else the university will actually be incurring a negative cost saving.

Rental/Purchase Guidelines

One of the most basic of all computer services management decisions regards the rental versus purchase of equipment. A number of factors must be taken into account:

1. time value of money
2. maintenance and insurance costs
3. resale value of equipment as a function of time

4. useful life of equipment
5. support of manufacturer

Illustrative Example

The following numerical example indicates the alternatives that are possible and the different conclusions that can be arrived at under different sets of assumptions.

Rental Cost for Computer System		
$5,000 per month for 24 months		$120,000
Purchase Cost for Computer System		
Purchase cost	$225,000	
Maintenance ($600/month for 24mos.)	14,400	
Resale Value (24 months hence)	(135,000)	
Net Purchase Cost		$104,400

A first impression is that purchase is the better option since it results in a savings of $15,600 over 24 months.

However, the conclusion is based upon comparing dissimilar expenditures since in the purchase example dollars are spent initially. Whereas, in the rental case dollars are expended over the twenty-four months. Because of the time value of money (a dollar being more valuable today than tomorrow since, for example, it can be invested) the dollars for rental and purchase cannot be compared unless they are referenced to the same point in time.

The technique to accomplish the comparison involves the present value method of the discounted cash flow approach to capital budgeting. Present value can be expressed as

$$PV = \left\{ \frac{1}{\left[1 + \frac{r}{100}\right]^n} \right\} D_n$$

Where D_n dollars that are expended n months from now
r discount rate — (% per month)
PV present value of the dollars to be expended

and

$$\left\{ \frac{1}{\left[1 + \frac{r}{100}\right]^n} \right\} \text{ is called the discount factor.}$$

The discount factor is less than one, indicating the present value of money is less than what must be spent in the future. This can be illustrated in a situation where $100 is owed to an individual with payment due one year hence. If $95.24 are deposited today in a bank paying 5% interest, the $100 will be available one year from today.

By computing the present values of the cash flows over the twenty-four months for the rental and the purchase options (Exhibit 3.5) (assuming a 5% interest rate), it can be demonstrated that rental is now the option that saves more dollars ($2,528.00).

Although the savings in this illustrative example are only ½%, a more realistic purchase vs. rental problem could result in appreciable savings through rental. In another situation due to the resale value, the time period involved, or the available interest rate, purchase may be the cost saving choice. The conclusion is that the comparison of the alternatives should be made on an equivalent basis using the present value technique.

Rental Advantages

In addition to possible cost savings from renting, certain risks are avoided. The contract may be cancelled on short notice if the equipment does not perform adequately or is not as cost effective as another available system. Rental also offers the flexibility to stay abreast of any significant changes that occur in the technology. Rental does not require the large outlay of cash that many times may not be available. Some users also feel that the support of rented equipment will be more complete than that provided purchased equipment. Evidence does not exist to support this assumption however. Rental of equipment also accrues purchase credit allowances for the renting university or any other Ohio public college or university.

Purchase Advantages

Purchase offers the advantage that if the equipment can satisfactorily meet the institutional needs for a long period (i.e., 5-10 years) purchase will result in cost savings. Purchase for a shorter period can many times result in cost savings depending upon the circumstances of the purchase (i.e., purchase option accruals, resale value, interest rates, etc).

A hybrid approach should be explored wherein the items with the longer useful life such as the CPU's are purchased while items exhibiting shorter useful lives such as peripherals are rented or leased. Such action should result in cost savings and at the same time minimize the risk of obsolescence of the computer system.

Recommendation

The Task Force recommends that when a university purchases computer equipment a system be set up to account for the depreciation expense associated with the equipment. If users are charged for the service they receive, a factor in the charge rate should include the depreciation expense of the equipment. Only with this factor included will the users be paying for the resources being consumed. **The Task Force recommends that the university also contribute to a reserve fund for the computer equipment so that, when the equipment needs to be replaced, the funds will be available and cash flow problems will not develop.**

EXHIBIT 3.5 CASH FLOWS FOR RENTAL/PURCHASE EXAMPLE

Rental Option

Month(N)	Cash Flow	Present Value of $1.00 at 5/12% Rate	Present Value of Cash Flow
1	–5,000.	.99585062	–4979.25
2	–5,000.	.99171846	–4958.59
3	–5,000.	.98760345	–4938.01
•	•	•	•
•	•	•	•
•	•	•	•
23	–5,000.	.90879636	–4543.98
24	–5,000.	.90502542	–4525.12
		Rental Total	–113969.48

Purchase Option

Purchase Cash Flow		–225000.00
Maintenance Cash Flow ($600/month for 24 months)		– 13676.34
Resale Value of 135,000 (24 months hence)		
	135,000 × .90502540	(122178.43)
	Purchase Total	–116497.91
	Rental Savings	$ 2528.43

4. Internal Procedures

Standards

Standards in a computer services installation are the procedures and rules under which analysts, programmers, operators and users work. The standards establish procedures to follow to obtain the best results. The term standard denotes a discipline which provides both guidelines and yardsticks. As a guideline, standards are used to establish uniform practices and common techniques, while as a yardstick, standards are used to measure the performance of the computer services functions. It is neither necessary nor desirable that all university computer services organizations adopt and conform to the same standards. However, it is beneficial and necessary that each institution establish a set of standards for the use of the staff and users.

Reasons for Standards

Establishing a set of computer services standards is necessary for the following reasons:

- Since computer services is an integral part of the institution, both the administration and the users are entitled to a high level of quality services that adherence to minimal but precise standards encourages.
- Since the area of computer services is so dynamic, the changes that occur often will be simplified if systems are designed and programs are written according to standard methods.
- New staff members will be able to contribute effectively faster if a set of standards exists and is available for introducing personnel to the standard procedures.
- The staff will find a convenient reference to checklists and agreed procedures useful in their work.

Basis for Standards and Techniques for Change

There should be a reason for each of the procedures described within the standards manual. The standards will be useless unless they are followed. To increase adherence to standards it should be stressed that the best standard is one that is more easily complied with than avoided.

It is impossible to produce a standards manual or sections of a manual, instruct the staff to read the manual, and then expect immediate compliance. A training session for those who will be affected will be needed for each major set of standards introduced.

Each standard should be subject to review and improvement at any time to ensure that they are up to date, realistic and useful. It is essential to establish some way for personnel at all levels to contribute to the standards manual. It should be stressed that each member of the staff has an obligation to recommend changes in writing to their supervisor. Each recommendation should be taken under consideration and the originator should receive a reply stating what has happened to his recommendation.

The standards manual should be a living document. Methods must be provided to allow revisions to existing standards, define the needs for new standards and eliminate efforts which have produced no valuable results. Regularly scheduled reviews of material help to keep the standards manual up to date.

Standards Manual Recommendation

The standards manual is the medium through which the installation's standards are documented and carried to all staff members. The standards manual serves as a reference book, and therefore a consistent structure and an excellent index should be provided.

Each university computer services organization should have a standards manual that is updated periodically with copies available to appropriate staff members, users, students, faculty and administrators. Exhibit 4.1 below is an illustrative example of the breakdown by sections of a model standards manual for a higher education computer services organization. This model for a standards manual includes many sections that may not presently be appropriate for some of Ohio's universities, because of the size of staff and scope of operations. As an organization grows, the sections and subsections listed in Exhibit 4.1 should be reviewed to determine which are appropriate for its circumstances.

Standards Manual Benefits

The benefits of a "living" standards manual for the organization is to ensure continuity and consistency of its functions over time, as well as to increase the level of quality service to the students, faculty, administrative and other users. Additional benefits in reductions in costs will result, since the costs of training new personnel will decrease. Other benefits include: reduced dependence on individuals by incorporation of uniform methods and practices; reduction of future costs due to program changes or conversions.

EXHIBIT 4.1

Sections of a Standards Manual (Illustrative Example)

Section 01. Introduction
01.01 Contents
01.02 Standards Policy
01.03 Manual Revision
01.04 Glossary of Terms

Section 02. Management
02.01 Mission
02.02 Organization
02.03 Training Policies
02.04 Project Initiation and Implementation
02.05 Project Control
02.06 Project Activity and Progress Report
02.07 Processing Administrative Applications
02.08 Processing Academic Applications
02.09 Personnel Attendance Reporting Procedures
02.10 Project Scheduling
02.11 Use of Facilties
02.12 User Relations
02.13 User Accounts
02.14 Functional Organization
02.15 Administrative Applications Personnel
02.16 Academic Applications Personnel
02.17 Operations Personnel
02.18 Operating Systems Software Personnel
02.19 Technical Support Personnel

Section 03. Hardware
03.01 Computer Configuration
03.02 Unit Record Equipment
03.03 Character Sets

Section 04. Systems Analysis
04.01 Methods
04.02 System Development Procedures
04.03 Proposal Preparation
04.04 Preparation of Program Specifications
04.05 Controls and Security
04.06 File Description
04.07 Process Chart Identification
04.08 System Documentation and Conventions
04.09 System Test
04.10 System Acceptance
04.11 User Documentation and Education
04.12 Revision of Production Systems
04.13 Optical Scanning Forms Design and Documentation
04.14 File Identification
04.15 Data Base Security

INTERNAL PROCEDURES

Section 05. Programming Standards
05.01 General Programming Guidelines
05.02 COBOL Standards and Techniques
05.03 ASSEMBLY Standards and Techniques
05.04 FORTRAN Standards and Techniques
05.05 JOB CONTROL
05.06 Forms and Forms Design
05.07 Disk Allocation
05.08 Program Library
05.09 Message Standards

Section 06. Operations Standards
06.01 Method of Work
06.02 Standard Procedure for Job Failure
06.03 Computer Output and Priorities
06.04 Safety Precautions
06.05 Card Handling
06.06 Card Punch Machines
06.07 Auxiliary Machines
06.08 Power On-Off
06.09 Console Rules
06.10 Printer Rules
06.11 Operator Indoctrination
06.12 Magnetic Tape Handling Procedures
06.13 Disk Pack Handling Procedures
06.14 Tape Library Procedures
06.15 Disk Dump Procedures
06.16 Security
06.17 Report Bursting and Copying
06.18 Computer Center Tours and Demonstrations
06.19 Remote Testing
06.20 Utilization Reports

Section 07. Software Standards
07.01 Operating System
07.02 Utility Program

Section 08. Data Control Standards
08.01 Data Control General Policy
08.02 Scheduling
08.03 Audit for Proper System Documentation
08.04 Computer Forms Printer Service

Section 09. Library Standards
- 09.01 Program
- 09.02 Documentation
- 09.03 Disk and Tape
- 09.04 Manual

Section 10. Retention Standards
- 10.01 General Policy

Section 11. Coding Standards
- 11.01 Installation Standards
- 11.02 External Standards
- 11.03 Character Convention for Program Coding
- 11.04 Flow-charting Symbols
- 11.05 Flow-charting Procedures

Section 12. Confidentiality Standards
- 12.01 General Policy
- 12.02 Software
- 12.03 Data

Section 13. Use and Charges
- 13.01 Equipment Utilization and Charge Policy
- 13.02 Procedures for Time Recording
- 13.03 Refunds and Reruns

Section 14. Documentation
- 14.01 Documentation Philosophy
- 14.02 Forms Index
- 14.03 Sample Documentation

Section 15. Glossary

Section 16. Exhibits

Documentation

One of the important areas of standards involves program documentation. The standards for program documentation define the level to which the programmer should support his efforts in writing. Since the main objective in generating a program is typically to have it operate properly, documentation of the program may be given little attention. However, documentation should be a vital part of the computer services organization and its importance and necessity should be stressed. Documentation has historically been associated with administrative data processing but consistent documentation standards are also desirable in the instructional area (i.e., computer-based instruction and computer-assisted instruction).

Reasons for Documentation

There are a number of reasons for having documentation standards and requiring adherence to them:

1. Documentation allows the installation to become less dependent upon its individual staff members who have designed systems and/or written programs. The absence of documentation tends to make personnel indispensable.
2. Documentation is a tremendous asset in any of the following common occurrences in a computer services organization:
    a. in completing a system or program in the development cycle
    b. in changing currently operational programs
    c. in program conversions necessitated by the use of a new machine or model of computer
3. Documentation provides the user and the computer services organization management with a clearer picture of the program, its capabilities and its limitations.
4. Documentation should increase the efficiency of the staff by having the programming and machine utilization on a better organized and disciplined basis.

Users of Documentation

The number of users of documentation include the following:

1. Programmers—programmers who did not participate in the original effort need good documentation if they are either required to make future changes or benefit from the techniques employed in previous efforts.
2. Operators—part of the documentation should include clear and meaningful operating instructions as well as instructions regarding procedures in the event of errors.
3. Internal users—documentation can acquaint new users with the capabilities of the program as well as being used as the basis for acceptance by the users.
4. Management—documentation serves the needs of management in the areas of general information as well as for purposes of review.

5. Outside users—as sharing among colleges and universities increases good documentation is a must. Standardized documentation may be desirable, however, adequate documentation is a necessity.

Levels of Documentation

There should be a number of levels of documentation depending upon the frequency of use of the program and the knowledge of the user. Level three may be appropriate for one-shot programs that will remain within the university and be used by only a few users. The documentation should include a program abstract and operator instructions.

Level two is for all other applications that are designed for use by a single department within the university and not for external distribution. The documentation should include, in addition to level three documentation, input and output formats, formal run sheets, fully documented source decks and a systems documentation folder.

Level one documentation standards are applicable to programs which are expected to be used by a number of people both within and especially outside the institution. As an example of a minimum level one documentation standard, Exhibit 4.2 contain the System Abstract from the College and University Systems Exchange (CAUSE). **Since adequate documentation is an inhibiting factor in exchange of application program between institutions, the Task Force recommends that the CAUSE System Abstract be adopted as a basic model for level one documentation procedures.** As institutions expand and/or change their documentation standards this model will become the goal for internally generated programs and/or specified to be used by software firms that are employed by any of the institutions.

The Task Force recommends that each institution have a set of documentation standards as part of its standards manual and furthermore that it maintain documentation on all Systems in accord with these standards.

EXHIBIT 4.2

College and University Systems Exchange (CAUSE) System Abstract

INSTITUTION : ____
OFFICE NAME: ____
ADDRESS : ____
CITY-STATE : ____ ZIP ____
CONTACT : ____
TELEPHONE : ____

ORIGINATOR/DEVELOPER: ____
SYSTEM NAME : Descriptive name, no acronyms
NUMBER OF PROGRAMS : COBOL: FORTRAN: OTHER:
HARDWARE USED : Manufacturer, Model, Core Size, Peripherals, etc.
OPERATING SYSTEM : Title, Number, Version, Level, Release, etc.

SUMMARY OF SYSTEM FUNCTIONS: Brief description of the system

MAJOR POLICY CONSIDERATIONS: Academic, administration and/or data processing policy implications.

EXCEPTIONS AND LIMITATIONS: Important aspects outside the capability of the system, hardware limitations, maximum file sizes, etc.

MAJOR FILES MAINTAINED:
(1) File name, description (including record size and file size)
(2)
(3)
(4)

MAJOR REPORTS PRODUCED:
(1) Report name, description (including distribution and use)
(2)
(3)
(4)

FIRST PRODUCTION DATE: ____
COMPUTER RUN TIMES: Times and transaction volumes—not costs, since charging rates differ greatly.

Confidentiality of Information

The problems associated with maintaining the confidentiality of particular information on campus existed before the widespread use of the computer began. The use of terminals, concurrent execution of multiple programs within computers, use of data for research, and other factors, both related and unrelated to computing, have caused these problems to increase.

Successful Procedures

The following computer services practices and procedures have been used successfully at various campuses for maximizing the confidentiality of sensitivity information:

1. Have the user present to the computer center written approval from authorized personnel when confidential data is to be accessed. User office thus defines what data are confidential and computer center regulates its access. Assignment of a data base guardian for each data base is one method for identifying a single point of contact for access, addition and deletion requests for data files.
2. Have the operating system check that job number is one that is authorized to access a particular file. If invalid access is attempted, job is dropped and operator notified.
3. Employ a system through which the output of a job is for example, given only to the user who presents a numbered receipt for the job, or stored in a locked box—the box corresponding to the account number of the user—with only users of that account number having access to that box—this locked box approach also decreases unauthorized use of someone elses account number.
4. Have a system of strict access to computer center and storage areas as well as a secure off-campus location, preferably confidential, for backup of sensitive information storage.
5. Minimize the number of people running programs that use data considered confidential.
6. Follow the procedures regarding data classified confidential by the government—have the computer dedicated to only one program when classified data is being used in order that another program can not extract confidential data during the processing cycle.

Recommendation

The Task Force recognizes that the methods to be employed for assuring confidentiality of data are closely related to and will depend upon the operational procedures for running the computer center at the institution. Operational procedures will differ because of differing environments and traditions on the campuses. **The Task Force recommends that each institution document a formal policy regarding the confidentiality of information that is adequate for its campus. The generators of the data should be involved in defining what data are to be treated confidentialy and releaseable to whom. Computer services should implement procedures within the computer centers to assure the required confidentiality.**

INTERNAL PROCEDURES

Security

Computer service has the responsibility for establishing policy and procedure that will assure that security is maintained for both the hardware and software at the computer center(s) as well as the information residing on files in the center.

Insurance Coverage

Hardware that is leased rather than purchased is, in most cases, insured by the vendor. Purchased computer services equipment is not automatically insured, but insurance should be considered if loss of the equipment would impact, in a substantial manner, the attainment of the institutions goals or objectives. The insurance policy should be written such that payment is made if damage occurs to the hardware due to any of the possible occurrences including both man-made damage (e.g., student riots) and other castastrophies (e.g., fire, flood).

Access to Facility

To minimize security problems to hardware and software in computer facilities "closed-shop" type of operation is recommended for major hardware facilities. In a "closed-shop" only the computer operators, operating system programmers, and supervisors are admitted freely. Their admittance may be controlled via key cards, combination push button lock or lock and keys. Others are admitted by prior arrangements and/or visual identification. Exceptions to "closed-shop" operation are made for specialized facilities and special users.

Since security of the facility may be violated without actually gaining access, other precautions may be warranted. These include: elimination of windows or replacement of standard glass window with impact resistant glass; locks on access routes to the computer center that can be instantaneously activated to deny access to the area of the center.

Software Security

Software security can be augmented in a number of ways. It is advisable to restrict the individuals operating certain terminals and dealing with certain master files. Access control is well handled by some of the latest operating system features which simultaneously require automatically emitted terminal identification numbers, permanent operator identifiers and passwords that change day by day. The combination of these allows the system to restrict file and system access by the location of the terminal and by the operator identity. Access code should also be employed to protect application programs and data files during batch processing. There should be some method of reconstructing files after minor processing errors or minor destruction of records.

If security of the computer center is a problem at a university, methods such as the above may be warranted. The price that must be paid to achieve the necessary security include the inconvenience caused to staff, students and faculty.

Data Security

Regarding the information that is considered crucial for the operation of the institution- copies of this information should be physically safeguarded at a secure, remote location, preferably one whose location is not common knowledge, and the information should be updated on a weekly basis. **The determination of the data that is considered crucial should be made at the vice presidential level of the institution. Computer services should then institute policies that afford the necessary security for the data while still maintaining a balance with the other needs of the users.**

Data Retention Guidelines

Although much of the data kept on file by computer services does not have a legally specified retention limit (exceptions are records, supporting claims for Federal grants, payroll, tax records), there should be institutionally defined retention limits. The absence of retention limits will lead to allocation of resources (dollars, space, personnel) at an increasing rate for the achievements of a questionable objective, specifically, storage of unnecessary data.

To facilitate the establishment of rules for retention of data not covered by present policy the following guidelines are offered:

1. **Users should be periodically (e.g., each quarter) requested in writing to renew the status of their data files or release them.**
2. **If a user does not respond to three consecutive requests to renew the status, the data should be released by computer services and the user and his office notified in writing of the action taken.**
3. **Users should be encouraged to move seldom used files (e.g., not used in one week) that are presently on active disk to tape or inactive disk.**
4. **In accordance with recommendation on user cost allocation policy discussed in Chapter III, users should be charged an appropriate amount for disk storage usage on a weekly or monthly basis. The user can then judge his own needs regarding the priority of data on active files.**

Evaluation

As discussed in Chapter II, two very important steps in the planning process involve evaluations. The first involves the determination of strengths and weaknesses of the organization. This determination establishes, in a sense, the first half of the "Here is where we are and where do we want to go?" question. Evaluation must also take place continuously, or at least at scheduled intervals, to determine how the computer services organization is proceeding with regard to its present goals and objectives.

Evaluations involve two factors: the criteria for evaluating, and the methods employed to carry out the evaluation.

Evaluation Criteria

The evaluation criteria should include clear statements that are related to the objectives of the computer services organization. Following the planning procedures recommended in Chapter II a statement of the objectives should specify the measurable criteria for evaluation. This may involve statements such as:

- 24 hours maximum turnaround time for all jobs starting Fall Quarter, 1975
- 30 minute turnaround time for 90% of student batch jobs starting Winter Quarter, 1975
- meeting previously promised application programming delivery schedules on at least 80% of all work

Many times the evaluation measures of the organization are also contained within policy type statements that are difficult to quantify. As such, evaluations are more difficult to carry out since subjective decisions are involved. Policy type statements that are applicable for computer service organizations include:

- adequacy of hardware
- availability of software
- reliability of hardware/software
- assistance to users
- concern and understanding toward users
- availability and timeliness of support programming

To be useful, statements concerning the above policies would have to be as definitive as possible and be formal statements that are made known to the staff as well as all users of computer services.

Methods of Evaluation

The evaluations should be conducted by both users and the staff of computer services. The methods employed for evaluation should include some combination of the following:

- computer advisory committee meetings
- formal user meetings involving director and senior staff for both academic users and administrative data processing users
- informal contact with users
- questionnaires and polls sent to users
- suggestion boxes
- written evaluations by staff members

Inter-Institutional Evaluations

Another technique that has not been employed to date, but which the Task Force recommends, is a system of inter-institutional evaluations. An approach might involve three phases:

- **Phase** I would involve the generation of an audit type of questionnaire addressing areas such as hardware and software resources, utilizations, facilities and staff skills, inventories and expenditure levels and components.
- **Phase** II would involve the completion of the audit questionnaire by one of the participating institutions.
- **Phase** III would involve analysis of the audit data followed by a visit to the campus by the participating institutional representatives where users and staff could be questioned regarding the audit data and the levels of service actually being provided.

The purpose of this exercise would be for the inter-institutional group to make positive suggestions regarding the computer services effort on each campus.

Recommendations

The Task Force recommends that a self-evaluation procedure exist for each computer services organization and that regular evaluations be made of computer services at each institution. The procedure should specify the frequency of evaluation, what items are evaluated, who conducts the evaluations, how the findings are documented and who receives copies of the evaluation findings.

Equipment Utilization

The purpose of equipment utilization information is to assist computer center management and university management efforts toward ensuring efficient and economical operation. In a commercial environment the objective many times is to increase equipment utilization to within 80% or 90% of full utilization. However, in higher education, in order to support the educational process, it may become necessary to have underutilized equipment, especially to support research. This decision regarding near full utilization or underutilization at university computer centers must be made by the institutional management because they are charged with resource allocation on their campus.

Types of Utilization Data

Utilization information is many times referred to as utilization statistics since data may be gathered over certain time intervals and inferred for other time intervals. Utilization statistics may be reported in various ways:

- Hours available for computing—total number of hours per month $(30 \times 24 = 720)$
- Hours scheduled for computing—total number of hours per month that center is operating and staffed
- Elapsed time from equipment meters
- Detailed busy and wait times for CPU, channels, peripheral equipment, etc. which is available through monitors.

The last approach, involving hardware and software monitors provides the most useful information for present day equipment where tasks within the computer are performed concurrently. Hardware and software monitors are discussed in appendix 4.1.

At present some of the campuses do not have system accounting procedures for measuring equipment utilization.

Recommendations

It is recommended that procedures for measuring utilization should be examined, the most productive set developed and adopted and utilized within the institution for justifying additions, upgrades and release of equipment. It is also recommended that a job accounting system be adopted at each institu-

tion that records job type (i.e., instruction, research, public service, administrative data processing). This will provide management at the institution with useful information they presently may not have access to. **The Task Force further recommends that the State of Ohio acquire performance monitoring equipment appropriate for the computer systems at the universities and make it available to the institutions on a rotating basis.**

5. Organization and Staffing Considerations

Overview

This chapter addresses the issues of the location or placement of the computer services organization(s) within the institution, as well as the structure for the organization(s). The advantages and disadvantages of combined or separate equipment facilities are discussed as are the staffing issues of location of personnel, training of personnel and position descriptions and classifications for personnel. An organizational checklist is included for periodic re-evaluation of the organization.

A few basic points should be stressed initially. First, an ideal organization will only be successful if the personnel are qualified and competent. If this is not the case, the type of organization will have little impact. The size of the organization will have a major influence on the organizational structure. Some of the larger institutions will have a number of management levels, while the smaller schools may have all of the organizational elements reporting to the computer services director.

Finally, management must constantly monitor the organization's effectiveness in terms of meeting the institutional and computer services objectives. A number of problems may exist within the organization such as personality problems or communicating problems, and these should be investigated before organizational change is attempted.

Organizational Considerations

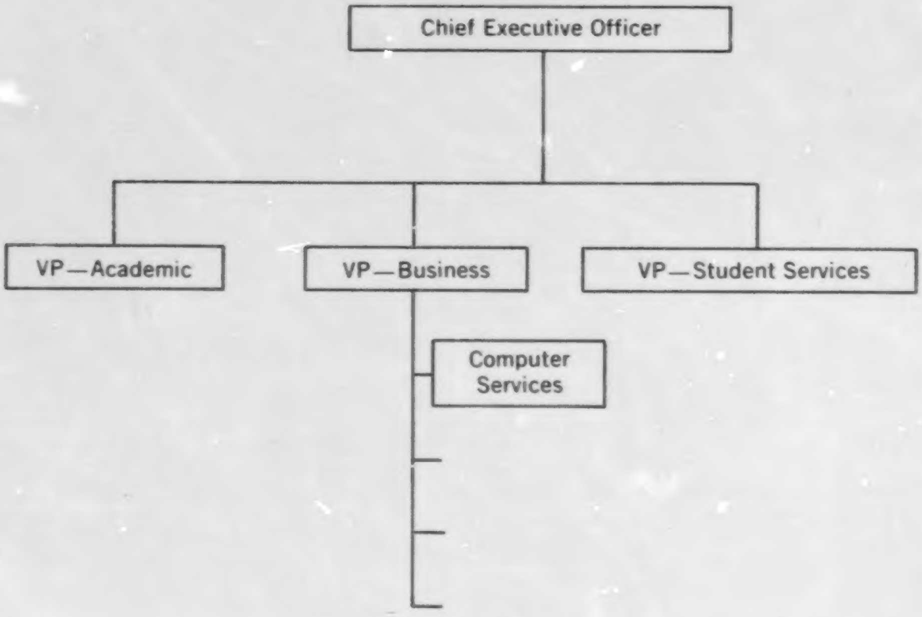
Since computer services is a service organization, its organization must be responsive and have good relations with its users. The placement of the organization can help or hinder this, and the question of its location becomes a sensitive one since there are conflicting interests and needs among the users.

Location/Placement

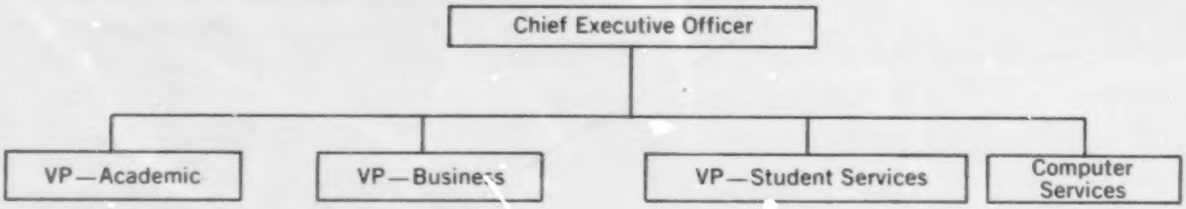
The three most common ways of locating the computer services organization in any type of structure are:

1. Centralized organization(s) reporting to the larger user
2. Centralized organization(s) reporting on a level with, but independent of, all users
3. Centralized organization(s) reporting at a level above the users.

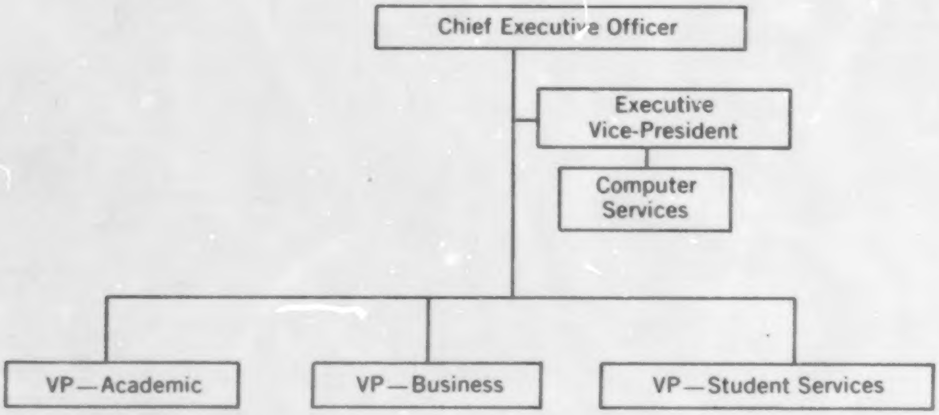
These three structures are illustrated in Exhibit 5.1.


Chief Executive Officer
VP—Academic
VP—Business
VP—Student Services
Computer Services

MODEL (1) Centralized reporting to largest user


Chief Executive Officer
VP—Academic
VP—Business
VP—Student Services
Computer Services

MODEL (2) Centralized reporting on a level with users


Chief Executive Officer
Executive Vice-President
Computer Services
VP—Academic
VP—Business
VP—Student Services

MODEL (3) Centralized reporting at a level above the users

EXHIBIT 5.1 PLACEMENT OF COMPUTER SERVICES ORGANIZATIONS

Factors Involved in Choice

Computer services organizations reporting to the larger user (1) have come about historically when multiple computer operations were combined and placed under the largest user. If accounting and payroll, for example, had the geratest requirement for computer services, the organization was located under the business officer.

It is a normal belief that if a particular organizational component on campus has organizational responsibility for computer services, its own needs will have priority over others. This feeling is apt to exist regardless of the quality of service and regardless of how statesmanlike the computer services director may be. The solution, which may have to be compromised for other reasons, involves placing the responsibility for the organization in the hands of a more neutral organizational component, either at the same level but independent of users (2) or a higher level (3). This assures more equitable service.

Having the organization independent of the users but reporting at the same level as the users (2) should result in fair and equitable service to all users on the campus. Having computer services report at a level higher than its users (3) has the significant advantage of the directors' greater awareness of the institutions' objectives and constraints on meeting these objectives, thus improving his capability for long-range planning. A disadvantage may exist if the computer services organization does not actually earn its higher place in the institution.

Office Computer Services Reports To

A number of options are therefore available with regard to what office the director of computer services should report. The options include having the director of computer services report, in a line capacity, to:

1. President
2. Executive Vice President
3. Vice President for Academic Affairs or Provost
4. Vice President for Finance or Business
5. Vice President for Research
6. Committee of Vice Presidents representing users (Provost, Research, Administration, Hospitals, etc.)

The president's workload on many university campuses is most likely too heavy to make option 1 feasible. Even if this is the case, when real crisis threatens, the president should devote his attention to the settlement of vital issues and lend his authority to resulting decisions. If, on the other hand, the president's schedule allows, option 1 does offer many advantages and is therefore desirable.

The choice of executive vice president is advantageous for those universities who presently have or contemplate creating an executive vice president position. The location of the office of executive vice president above those competing for computer service should assure fair and equitable service to all users. In the area of management of the institution and its scarce resources the executive vice president will have a good perspective of the areas in the institution where the application of computers will result in the biggest payoff. He will also be capable of deciding the proportion of computer services to be devoted to the overall objectives of the institution in the areas of instruction, administration, public service and research.

The choice of option 3 (vice president for academic affairs) or option 4 (vice president for business affairs) or option 5 (vice president for research) has many times been made as a result of where computer services first began providing service on the campus. It has also come about as a result of centralization wherein the larger computer center has absorbed the smaller center.

As of 1970 the National Science Foundation Inventory of Computers in Higher Education reported that 1326 institutions reported 1303 administratively independent installations having some kind of computer. Of the 847 public institutions installations, 522 were combined installations supporting instruction, research and administrative data processing. Approximately 160 schools had computer installations reporting to the chief academic officer. Computer installations reported to the chief business officer in 120 schools and to the president of the institution in 115 schools.

The sixth option of having computer services report to a committee of officers of the institution has been used successful at some institutions. The major problem involves making difficult decisions within a committee atmosphere. The benefits include having decisions made by high level executives of the institution who have the larger picture of the institution and its goals. Equitable service for all users should also result from a committee of vice-presidents.

Recommendation

No single organizational placement has been found that resolves all conflicts. This is the reason for the variation that exists today. **The Task Force recommends that the best placement for computer services depends upon the style and nature of each institution. The guidelines should be that the organization's location encourage equitable user service and allow for a short chain-of-command between it and top management.**

Organizational Structure

An approach to organizational structuring can follow product, geography, customer type or activity lines. Within a higher education institution only the last two are appropriate. The types of customers can be categorized as instructional, research, administrative and public service. The needs of these four different customers were discussed in Chapter I.

The activities can be categorized as:

- computer operations
- software programming
- applications-design and programming
- internal administration

The last function involves such tasks as customer and vendor liaison, personnel administration, long-range planning, analysis and trade-off studies, standards, procedures and budgeting. These functions are best handled by a staff person or organization reporting to the computer services director.

As discussed previously in this manual, the spectrum of computer services organization within Ohio's institutions is indeed wide. In some of the smaller schools all of the above functions are carried out by a one or two person staff. In most of the larger schools there is a group of professional people responsible for software programming. Another group for applications programming, etc. In general, the larger the computer services organization, the more likely that functions will be separated into distinct organizational units. Wnat follows then is a model that should guide the smaller schools as their organizations tend to enlarge, as well as the schools presently having large computer services organizations.

An overall organizational chart for an organization structured according to functions with the applications area separated by skills is as follows:

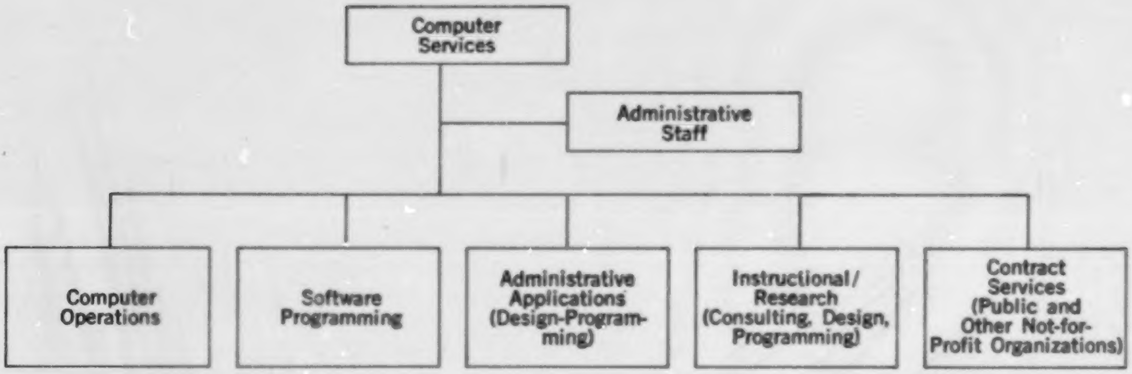

Computer Services
Administrative Staff
Computer Operations
Software Programming
Administrative Applications (Design-Programming)
Instructional/ Research (Consulting, Design, Programming)
Contract Services (Public and Other Not-for-Profit Organizations)

EXHIBIT 5.2 Organizational Chart for Basic Model

This is a basic organizational model which can be adjusted according to the local situation. For example, there may be significant demand for education and consulting that would warrant another unit reporting to the director or the number of software programmers may not warrant a separate unit.

ORGANIZATIONAL AND STAFFING CONSIDERATIONS

Combined/Separate Equipment Facilities

In 1969 more than half of Ohio's public universities maintained separate computer facilities for administrative data processing and academic computing.

Historically, there have been numerous reasons for computer facilities being separate at institutions:

- Thoughts that administrative data processing computer needs were fundamentally different than academic needs thus requiring separate and different equipment.
- Attempts to use common hardware and software before the mid 1960's many times failed because the many needs of various users could not be satisfied simultaneously within the available state-of-the-art of computing.
- Federal research grants were available to support the growth and expansion of research computer facilities. Thus instructional/research computing grew up independently of ADP.

Technical Problem

The technical problems of simultaneous use of facilities by academic and administrative users have decreased significantly since the early 1960's. The introduction of faster and larger hardware and the development of software allowing programs to operate "apparently simultaneously" have led to the realization that the difference between administrative and academic data processing are much smaller than earlier thought. This realization has led many universities including well over half the public universities in Ohio to merge ADP and academic data processing.

Operational Problem

The operational problem of servicing large numbers of instructional users with short turnaround times as well as ADP users with tight reporting schedules can be solved. This has been well demonstrated at both large and small institutions in Ohio and elsewhere. In addition, as on-line terminals systems become more evident on campuses, in instruction as well as ADP organizations, the computing requirements for the two types of users can be efficiently handled from the same facility.

Recommendations and Benefits

The Task Force feels that under most circumstances the best organization is one that operates a joint center managing hardware for instruction and research as well as ADP. The disadvantages to such an organization are minimal and the advantages substantial:

1. Combining the computer resources into a single organization allows the installation of more powerful and flexible equipment at less cost than two or more separate centers.

2. Computer service personnel, both a scarce and a costly resource, can be used more effectively with substantially less duplication of system support effort.

3. A larger systems programming staff at a combined center will allow more exposure of application programmers to systems knowledge.

4. In the joint center multiprogramming capabilities must be more fully utilized resulting in a more efficient use of computing resources than could be obtained at multiple centers on smaller equipment.

5. Large data base manipulations, for both ADP and research applications, will benefit from the consolidation of the hardware facilities.

The disadvantages are possible diseconomies of scale and complex span of control in serving a large number of varied users.

The Task Force thus recommends that those institutions presently operating separate hardware computing facilities should re-examine their operation with regard to the advantage of a joint hardware center for their institution.

Location of Personnel

One of the issues regarding computer services personnel is their location within the organizational structure of the university. There are at least five types of personnel activities involved.

- Machine operators
- Software (Operating Systems) Programmers
- Programmers (Application and Maintenance)
- Academic Consultants
- Systems Analysts

The best practice involves centralization of the first two types of personnel within the computer services organization. Since their efforts are directly involved with the computer and associated equipment, it would make little sense for having these people decentralized about the campus.

The question regarding the centralization or decentralization of systems analyst and programmers is not as easily answered especially for the larger schools. In these schools some users may have sustained computing needs that could justify having systems analysts and/or application or maintenance programmers located within their organization. The computing personnel in this case would theoretically have a better understanding of the users area and could be more responsive to the user organization needs. However, there are other significant disadvantages to this decentralization such as keeping the analysts and programmers abreast of the changing computer technology as well as decreased effectiveness from separation of talents.

In the smaller universities the decision is not as difficult since user organization are either not large enough and/or do not have sustained computing needs to justify their own analysts and programmers. Thus the choice of having systems analysts and programmers within computer services is best.

Another approach involves the formation of a separate university wide systems department wherein the systems analysts are located. A variation of this is presently in use at the University of Cincinnati, The Ohio State University and Miami University and it may be the future trend for many institutions. In this so called systems department would rest the responsibility for all systems activities within the institution including management analysis, operations research, methods and procedures, organizational and computer systems analysis.

Thus there are at least three choices for locating the systems analysts and programmers on the campus;

- Include them in the computer center organization
- Distribute them throughout the campus to the organizations they are supporting (ADP's would go to registrar, bursar, student records, etc., and non-ADP's would support instruction and/or research)
- Form a separate systems organization on campus to house the talent

The advantages and disadvantages of each approach are listed in exhibit 5.3.

The creation of a separate systems department may be the forerunner of organizational changes that will take place on many campuses in the future. To date it has not demonstrated that it should be recommended as desirable.

Since with some additional effort on the part of computer services staff, most user requests can be handled equitably and realistically by a centralized staff, and because of the efficiencies and effectiveness afforded by centralized pooling of talents the placement of analysts and programmers within computer services seems most reasonable.

Recommendation and Benefits

The Task Force recommends that the systems analysts and programmers not be contained with the user organizations. The benefits include improved effectiveness through pooling of talents and association of analysts with systems programmers. In addition the task of keeping analysts abreast of latest technology will be minimized. The resulting organizational model will have four functional areas reporting to the computer services director.

- Computer Operations
- Systems Programming
- ADP Systems Development
- Academic Systems Programming and Consulting

EXHIBIT 5.3

Location of System Analysts and Application Programmers

I. Separate Systems Organization

Advantages:

- Coordinated effort in data base design
- Single point of control and responsibility for data bases
- Pooling of talents results in improved effectiveness
- More responsive to management needs for implementing modern business practices through computers (PPBS, Simultations, PERT)

Disadvantages:

- Increased overhead due to formation of new organization
- By being apart from hardware and closer to application areas difficulties in staying abreast of the technology intensified.

- If the systems organization does not have responsibility for programming they may be apart from software.

II. Incorporated into User Organizations

Advantages:

- Better understanding of users areas so that productivity in designing applications is increased
- More responsive to user organization needs

Disadvantages:

- Only viable for sustained user needs
- Same as for separate Systems Departments (i.e., staying with technology)
- Possible duplication of efforts as more areas acquire their own applications programmer/analysts
- Lack of coordination on data base design

III. Remain within Computer Services Organization

Advantages:

- Coordinated approach should improve overall effectiveness
- Best method of keeping analyst up to date with hardware, operating systems and other software
- Pooling of talents results in improved effectiveness
- Career path continuity improved

Disadvantages:

- Possibility of lack of effectiveness to user — because of imperfect knowledge of users needs and problems
- Tendency toward less documentation

Training

The American Association of Junior Colleges recently stated, "By far the most critical factor for success or effective computer utilization is competent professional personnel, especially in the area of systems design and applications implementation."

In addition to the acquisition of the most competent staff members initially, training must be employed to keep staffs current and to expand their capabilities. Obviously, training requires the time and effort of the computer services organization management unless all training is to be accomplished at, for example, manufacturers' schools and off-campus seminars. If on-campus training is included, the manager must decide to sacrifice some current capacity for future capacity the training will afford.

If the organization is small, there should still be a training program for the staff. A good approach is to maintain a training program but limit its size to that which will fit the institutions resources. A technique to conserve resources would be to have the senior member(s) of the staff conduct a two-hour training session once every two weeks for the entire staff. The topics could concentrate on those issues that have the greatest impact on the work being done by the staff at the time, rather than on trying to raise their general level of knowledge of the staff. Members of the faculty and guest lecturers from other university computer services organizations can be invited to conduct some of the training sessions.

A possibility exists in the training area of interinstitutional cooperation. An individual who attends a manufacturer or vendor course from one institution could attempt to disseminate the information obtained either in writing as a set of notes and handouts or verbally by recreating the seminar for representatives from interested schools. Universities could also combine resources to hire a consultant, manufacturer, or software firm in order to present a seminar or course at a convenient location within Ohio. Minimizing the expense of travel and accommodations can make this arrangements attractive for many schools with limited training and travel budgets. A successful pilot project has already been accomplished by the IUC/ADP group on Systems Analysis and Design training. This can and should be extended to include similar programs in the research and instructional areas.

Job Descriptions and Classifications

Because of the complexity and high cost of computer centers, it is vital that they be organized, staffed and managed with precise personnel goals in mind. It is inconceivable that the personnel requirements of a computer center can be properly expressed and fulfilled unless these requirements are documented in writing and made available to the entire staff of the department. Such documentation will force the manager to formulate the personnel requirements of the department and will permit staff members to know with certainty what is required of them.

Foremost in the documentation should be an organization chart. **The Task Force recommends that every computer center create and maintain an organization chart which reflects the title and reporting relationships of every employee in the department.** While the organization chart need not identify employees by name, it should be sufficiently detailed that every employee's job title is explicitly represented. This should include not only the titles of full-service personnel, but also those of student, part-time, on-loan, and any other personnel who contribute time to the organization. Because the function of the organization chart is to elucidate the current working relationships of the staff, it should be revised as frequently as necessary and made available to every member of the staff.

An organization chart alone is not enough, however, to inform the staff of the total personnel requirement and the full extent of their working relationships. Although organization charts are frequently devised with direct (solid line; vertical) relationships and indirect (dotted line; horizontal) relationships, the amount that can be graphically represented is limited. The chart should be supplemented by written descriptions of all procedures the staff is expected to follow in day-to-day communication with one another and preferably with personnel outside the department as well. Equally important, all personnel policies which staff members are expected to individually observe should be documented in writing. For example, policies on shifts and hours, the taking of leave, confidentiality of information, etc., should be explicitly recorded. **The Task Force recommends that every computer center create and maintain a detailed and highly precise job description for every title in its organization chart.**

There are at least three ingredients which must minimally be included in a job description if it is to be effective:

a. a statement of the nature of the work performed in the job
b. a detailed and exhaustive list of the specific duties and responsibilities of the job
c. the minimal qualifications an employee must have to perform the job

The statement of specific responsibilities is the most important reason for a job description's creation and, as such must thoroughly address both the general and the specific requirements of the job. Such a statement should include at the very least:

a. the positions to which this job is reportable
b. the positions which this job directly or indirectly supervises
c. the contacts with all other persons (or offices) which are or are not permitted both inside and outside the computer center
d. the written communication which is required to properly document the performance of the job
e. the power and limitations of decision-making in the job.

Examples of the latter might be reflected in job descriptions as follows:

1. A **project leader** may interview applicants and recommend who to hire and promote. A **manager** hires and promotes.
2. A **manager** may solicit product information from a vendor but may not divulge budget information about the computer center. A **director** may divulge budget information but only request acquisition by the purchasing department.

It should be noted that authority is to be both granted and constrained if the job description is to be effective. Of no less importance is the necessity of listing details of the job such as machines which will be operated, routines which will be performed, the amount of weight which must be lifted, etc.

While the statement of duties strongly implies the qualifications required in a job, an explicit statement of qualifications should also be included. The usual, but by no means only, ingredients on qualifications are:

a. degrees and/or fields of formal education required, if any
b. special training or skills required over and above formal education, if any
c. years and type of experience required, if any

If a computer center is inadequately staffed or funded to train employees on the job, the qualifications for a job can be used to exclude from consideration any applicants who fail to have the prerequisite training and skills. Similarly, if a particular type of experience is required for proper performance of a job, the applicable experience should be specified as a prerequisite.

Only after a computer center has created its organization chart and job descriptions should the determination be made as to whether the job constitutes classified or unclassified civil service, administrative, or faculty employment.

Before a computer center can objectively assign a job to one of these categories, the university must formulate precise policies as to the manner in which these categories are constituted. The computer center as well as other campus organizations, should then consistently apply the rules of the university and the Ohio Civil Service statutes as well as the position descriptions in assigning each job in the organization to a category of employment.

A university, and in turn a computer center, may have cogent reasons for designating certain classes of jobs such as computer programmer to categories other than those provided under civil service. Universities traditionally recognize faculty and selected other members of their staff as sharing a special peer relationship quite apart from the support staff of the institution and accordingly grant this group a special status. As long as universities remain autonomous and consistently distinguish such staff, professional employment outside the civil service should be possible. Where university policy permits, it is reasonable for computer centers to employ both civil service and non-civil service personnel—as determined by the job description and its categorization. Once the job is categorized, the computer center should consistently follow university salary policies for hiring and promoting employees outside the civil service.

Organizational Checklist

To establish how well the organization is prepared to carry out the functions the following questions must be answered periodically and appropriate action taken:

Has a formal organizational chart been prepared and is it current?

Is the plan of organization based predominantly on functions and services rather than around personalities?

Is the organization adequately staffed to perform its assigned functions?

Are the required working relationships between all components of the organization understood?

Does the organizational chart reflect the actual decision-making process?

Is the responsibility for computer services functions clearly assigned and defined in writing?

Are organizational policies clearly defined in writing to permit consistent application?

Are organizational policies reviewed periodically and adapted to changing conditions?

Is there an effective method of communicating the approval and establishment of new or changed procedures to all users and concerned departments?

Does computer services management personnel receive regular reports that facilitate direction and control of the operation?

Are costs analyzed and compared with other institutions or service centers?

6. Inter-Institutional Cooperation

Introduction

"Cooperative activity between or among several institutions has been with us for many years. However, the prevalent pattern of institutional activity has been, and probably always will be, one of striving for academic excellence through competition. Perhaps the stress and pressures on higher education in the decades ahead will necessitate a more balanced proportion of cooperation and competition." These are the words of an Ohio private college vice-president, but it most likely reflects the sentiment of an increasing majority in higher education.

Expenditures for computing services have grown rapidly within Ohio's public universities up to the present time (from 1969 to 1972 expenditures have nearly doubled, a 24% annual compound rate of growth). There is little likelihood that this rate of growth can continue since higher education budgets are becoming increasingly tight with the Carnegie Commission and others indicating this will be the trend throughout the seventies. Yet unfulfilled computing needs, which are presently not being satisfied because of scarce resources, will increase if the computers' use in instructional (e.g. computer-based instruction) and administrative applications (e.g. PPBS) expands as rapidly as is being projected. Thus, service needs will expand faster than institutional budgetary increases.

Sharing of institutional resources is one of the solutions. One of the areas where college and university cooperation has been demonstrated to be successful is in the areas of computing. Examples within Ohio are the Southwestern Ohio Regional Computer Center (SWORCC) and the Northwestern Ohio University computer Center (NOUCC). Other nationwide sharing arrangements are in North Carolina, Michigan, Iowa, New England, etc.

The current trends in hardware, software, data and higher education financial support clearly mandate more inter-institutional cooperation. Hardware trends are still toward decreasing the unit cost of computing by increasing the size of cheap memory and improving the utilization of very high speed central processing units (CPU) so that more logic and calculations can be performed. Software is becoming increasingly complex and expensive to maintain locally and more available commercially in a generalized form. Numerous large data bases (e.g., Library of Congress, Census Data) are being made available in machine readable form and the ADP trend is toward large inter-related data bases ith less duplication of basic data (e.g., names and addresses) and increasingly complex referencing and classification schemes.

These, coupled with the current financial constraints evident in all of higher education, dictate that cost-effective means for inter-institutional cooperation be found.

This chapter will concentrate on the possible areas for cooperation, the cooperative efforts involving computer services within Ohio and the nation, the suggested approach to defining areas for cooperative efforts, the issues involved and finally the recommendations of the Task Force regarding inter-institutional cooperation.

Inter-institutional Cooperation in Ohio

Ohio has a reasonably strong history of projects and interest in inter-institutional cooperation in higher education when one considers the separate Boards of Trustees and relatively unique program/mission/community and size aspects of the institutions. In the area of computing services, examples include:

1. **Hardware Swapping**

   The economical swapping of hardware among institutions such as the sale of The Ohio State University IBM Model 360/75 to Bowling Green State University which resulted in an annual cost avoidance of $113,000; the sale of the IBM Model 360/65 at the University of Cincinnati to Wright State University resulting in a one time cost avoidance to that institution of $84,000. In addition to these examples of the use of accrued credits at one institution to reduce the effective price to another institution a more complex example, which involved lesser savings, is the one between the University of Toledo, Michail J. Owens Technical College and IBM. Each of these is discussed in Chapter III.

2. **Regional Centers**

   Sharing of computing power is evidenced by at least four different ventures:

   > The development and operation of the Southwestern Ohio Regional Computer Center by the University of Cincinnati and Miami University; the development and operation of the Northwest Ohio University Computer Center by Bowling Green State University and the University of Toledo; the evidence of interest on the part of the University of Akron, Youngstown State University and Kent State University in exploring a similar venture in Northeastern Ohio and the planning regarding sharing being done in the Cleveland area involving Cleveland State University and Cuyahoga and Lakeland Community Colleges.

3. **The Ohio Board of Regents' Uniform Information System**

   Extensive work of institutional task forces and the use of institutional computer services has been required by the development and implementation of the Ohio Board of Regents' Uniform Information System from 1966 to date. This system is the first and only integrated statewide system in the nation collecting individual student, staff, and space inventory, and activity data in a common format. In addition, the use of these data in combination with financial reports supports a reasonably sophisticated instructional resource analysis model which in turn is integral to the budget support models which in turn are monitored with respect to performance by the Uniform Information System.

Total costs of this system are not known since each institution provides significant support in translating data into common formats. However, the Regents' level cost is clearly minimal in that only 3 F.T.E. staff at the Regents and $120,000 of computing are required to maintain this system of extensive data on over 290,000 students, 40,000 staff and 90,000 rooms on the 57 campuses.

4. **The Development of the Ohio College Library Center Project for Cataloging Library Books**

   Here centralized hardware is used to access existing catalog records and to produce catalog cards for each of the public and private libraries in Ohio in the specific format appropriate to each institution. At this point cards are produced at a cost of 3.4 cents each as opposed to approximately 7 cents by traditional means which represents an annual savings to the members of from $25 to $1600.

5. **Information Exchange**

   The exchange of information and techniques among the various data processing directors through the Inter-university Council for Administrative Data Processing, which has met on a regular basis for over three years.

6. **College and University Systems Exchange**

   A number of the universities are members or considering membership in this national, non-profit organization founded in 1970 to promote the exchange of administrative data processing systems, procedures and techniques. An example of the potential benefits in this kind of exchange is provided by the case of the adaptation of the University of Illinois student scheduling system by The Ohio State University. Although nearly two "people years" of programming and systems work were expended by Ohio State in converting the Illinois system to the Ohio State data bases and scheduling procedures, the project was judged to be cost effective in that Illinois had over 36 people years of programming in the system. The time and cost to do it alone or through an outside software firm was in excess of five times the amount actually expended.

7. **National Center for Higher Education Management Systems at the Western Interstate Commission for Higher Education (NCHEMS/WICHE)**

   Seven of the twelve universities are participants in the work of NCHEMS/WICHE. The principal activities of this center have been to develop planning/management tools for higher education administration. Their products are generally adjunct to the internal administrative data processing systems and include such things as:

- Data Element Dictionaries with common definitions (for exchange purposes) in the Student, Personnel, Space and Financial areas.
- Program Classification Structure for grouping institutional data into common programs.
- Resource Requirements Prediction Models. For institutions to use in forecasting current personnel and financial data.
- Induced Course Load Matrix. A program for converting enrollment data in courses into demand factors by source of demand.
- Student Flow Models. For forecasting enrollments.
- Faculty Activity Analysis Procedures.
- Training in the use of NCHEMS products.

8. **Other Ventures**

   In addition Ohio's involvement in groups such as the Big Ten Data Processing Directors, the College and University Machine Records Conference (more than 900 administrative data processors, registrars and financial officers met for three days in Columbus in 1972 to exchange ideas and techniques) are examples of inter-institutional cooperation within Ohio.

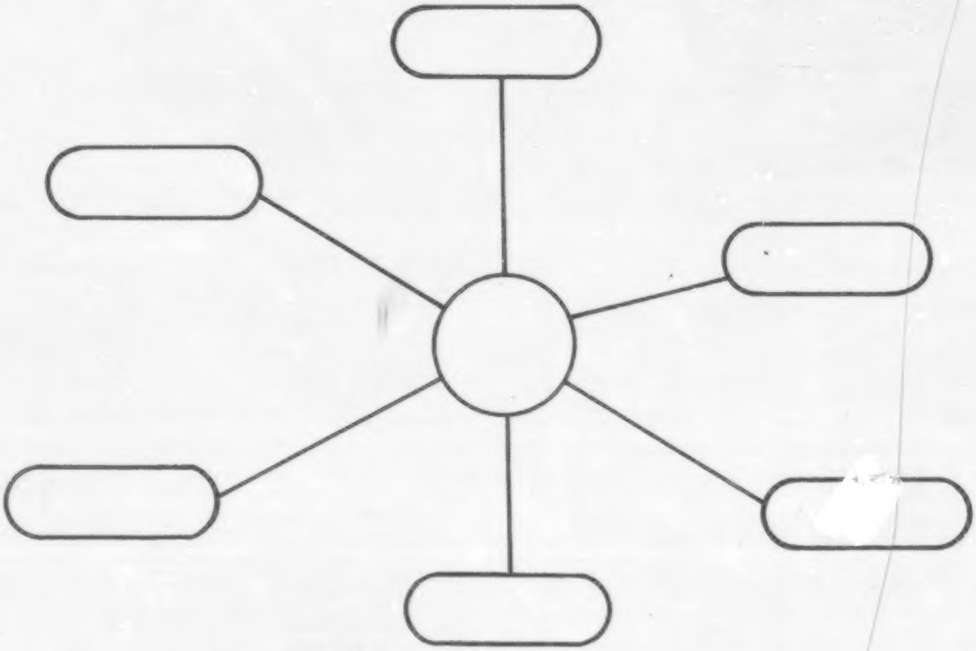
Inter-Institutional Cooperation Nationwide

In addition to the nationwide efforts promoting exchange of previously developed and tested ADP application programs (e.g. CAUSE) and promoting joint user development of planning/management tools for higher education (e.g. WICHE/NCHEMS), there are a significant number of institutions sharing computing throughout the nation. For example, as of 1971 there were at least 36 educational computer sharing networks in existence. Sixty-six institutions of Higher Education were involved in some shared use of computer resources.

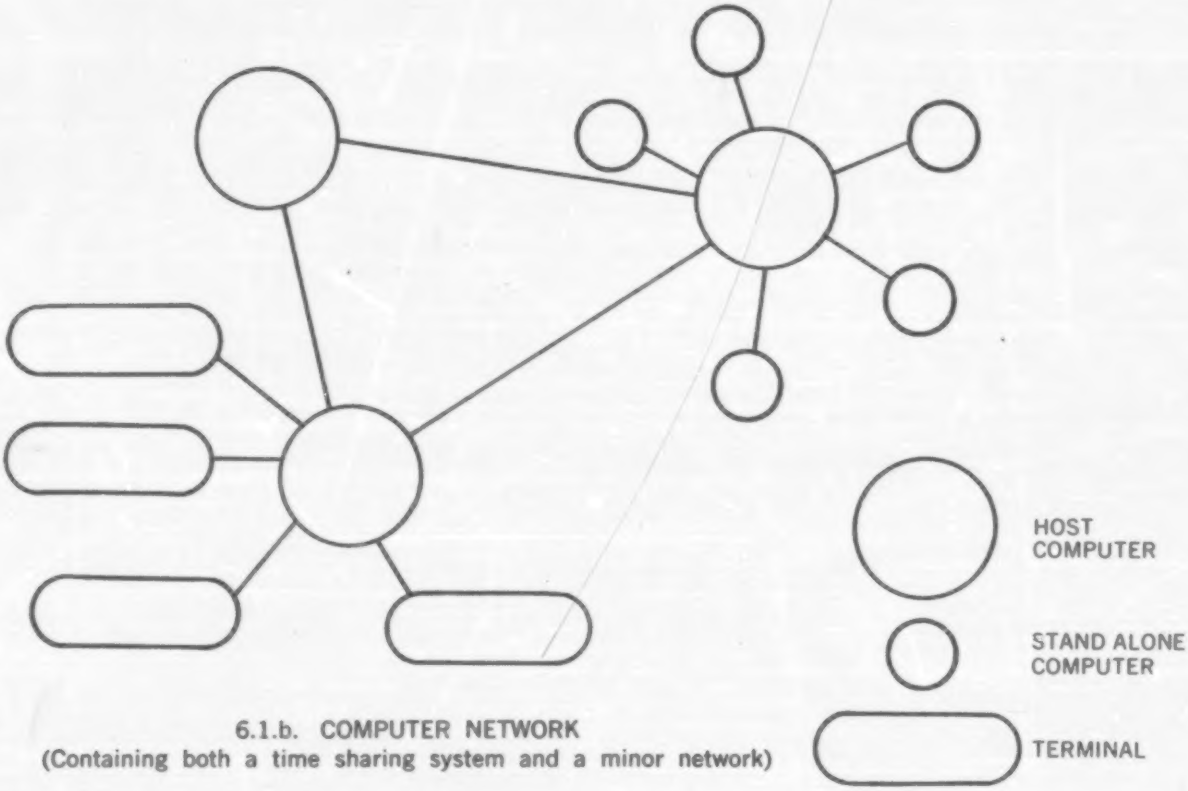
The shared use ranges from small colleges pooling their resources to set up a regional computer center or acquire service from an existing center (e.g. a university computer center) to the inter-connection of multiple computers on individual campuses to form a computer network.

Time Sharing and Computer Networks

Time-sharing (T/S) involves the use of **one central computer** (host computer) by multiple users via terminals that are usually remote from the computer (Figure 6a). T/S has had quite an impact since its introduction in the early 1960's. Computer networks involve the connection of **multiple stand-alone computers** located physically apart from each other so that users of any machine will have availablity of the host machines in the network (Figure 6b).



6.1.a. TIME-SHARING SYSTEM


HOST COMPUTER
STAND ALONE COMPUTER
TERMINAL

6.1.b. COMPUTER NETWORK
(Containing both a time sharing system and a minor network)

EXHIBIT 6.1 Illustration of a Time-Sharing System and a Computer Network

INTER-INSTITUTIONAL COOPERATION

Networks, as well as any sharing ventures, are based upon the proposition that networking or sharing is more satisfactory or economical for delivering certain classes of computer services than is autonomous, self-sufficient operation. Networks are usually designed with one of the following three goals.

Purposes of Networks

1. Cost reduction — jobs sent through telecommunication facility to another location so that more economical service can be obtained (in higher education a typical area would be instructional computing).
2. Resource Sharing — job sent to another location in order to obtain a variety of service not available locally (applicable to research and possibly to instruction).
3. A combination of the above.

Networks are much discussed and written about these days. EDUCOM has devoted all of its Fall and Spring conferences to the concept of networking since Spring, 1972, and the National Science Foundation, which funded the establishment of about 25 regional computer centers from 1968 on, is now making funds available for studying a national computer network and/or experiments associated with network concepts. Prestigious private and public schools such as USC, CAL TECH, and UCLA have contracted with A. D. Little, Inc. for the development of a plan for creating a functionally specialized computer network with the three nodes of the network located at each school, specializing in production processing, time-sharing, and problem solving, respectively.

Other examples exist demonstrating the sharing or exchange of resources occurring nationwide. During 1970-71, for example, the United States Naval Academy installed an exact duplicate of the well known Dartmouth Time-Sharing System at an estimated cost of $2.2 million.

Appendix 6.1 contains a discussion about a number of sharing arrangements that exist nationwide.

In addition some other nationwide changes are taking place in other states, for example,

- Control of leasing and purchase of equipment (Florida, Mississippi)
- Combined multi-agency and educational facilities (Colorado)
- Computer networks and regions (California, Illinois, New Jersey, Michigan)

A very good discussion concerning regional centers and networks is contained in a February, 1973 book "A Study of Regional Computer Networks" by F. W. Weingarten, et al published by the University of Iowa.

Approaches to Cooperation

The Task Force believes that the sharing of computing power will achieve the greatest degree of success if a functional approach to sharing is pursued. As previously mentioned (Chapter II) computing in higher education can be categorized as follows:

1. Teaching Languages and Concepts
2. General Problem Solving
3. Production Processing

Functional Categories and Areas for Cooperation

Within each of these areas there are significant opportunities for cooperation with regard to hardware, software and data. Furthermore, operating in a functional context permits the evaluation of the cost-effectiveness of a particular alternative or set of alternative opportunities. A few of these are discussed below.

Teaching Computer Languages and Concepts

The function of teaching computer languages is the best understood and most universal application of computing in post secondary higher education. The FORTRAN languages is most frequently used to train students in Ohio although COBOL, BASIC, ASSEMBLER, APL and PLI are also used in training languages. The principal method of providing this service is through batch processing where student jobs are submitted and later pick up at a particular center. In Fall 1972, as many as 20,000 student jobs of this type were run per day in the 12 public universities.

Interactive student programming has been provided as a means for teaching languages and has gained significantly in academic use. Here the student uses a terminal to write and debug his program. Because the response to many errors is immediate, much less time is required to get a program operating. Interactive processing is currently more complex and more expensive to provide than batch processing, although there are a large number of opinions regarding the most cost-effective method of providing interactive processing. In Autumn 1972, there were approximately 250 terminals available for interactive processing of student computer language instruction among the 12 university campuses.

In addition, there is training available in less frequently used languages (e.g., SNOBOL, ALGOL, SIMSCRIPT, GPSS) and in various specialized applications of computers such as graphics and CAI.

Problem Solving

The use of computers in problem solving ranges in complexity from simply providing a compiler which a researcher or data processor can use to write programs for solving problems, to providing elaborate statistical and data manipulation packages and a standard data base for extensive research. The simplest function, compiling and testing services, is similar to the teaching function whereas the more complex problem solving applications overlap somewhat with production processing. However, in the midground, there is a significant amount of activity supported in the development of complex programs and in providing "one time" calculation services.

Potential sharing of compiler services, research support packages, and some research data bases (such as the Dartmouth Social Sciences Data Base) should clearly be explored. Also, there are considerable advantages in sharing information on the less frequently used languages and tools for problem solving as campuses develop expertise. For example, a person developing course material for CAI in the Course-writer language can be aided considerably by knowing more about what others are doing or have done in this "problem solving" area.

Production Processing

A variety of computer services involve providing support to a production process. Examples include such things as payroll, student registration, student admissions, the production of learning through CAI courses, and a variety of testing and major research data collection and reduction applications. As previously mentioned, there is a grey area between problem solving and production although in this area it is generally clear to the user whether what he is doing is "testing" a program (perhaps with voluminous data) or expecting a production run. The most important aspects of production processing are the generally rigid requirements from a timing and control standpoint.

Much production processing involves activities that are very critical to the various operations of the institution and which are frequently done in a unique way. For this reason, there has been less cooperative effort put forth in this area. However, there clearly are opportunities for considerable cooperation in various production processing areas. The most successful examples to date have been in areas that have reasonable standardization of data files and procedures such as library card catalog production or federal student loan program administration. More attention is being paid to the development of systems that will enhance cooperation, although at this point there are still great difficulties in sharing.

Software Sharing

Software programs can be available for general use by a large number of users (eg., a compiler for use by students in writing FORTRAN programs, or a utility program for sorting files) or may involve only one major user and be written to meet this particular need in a unique way (eg., an institutional COBOL program for printing grade reports, a researchers FORTRAN Program for a model of physical or social phenomena). In addition, software programs can be interrelated into a complex system of programs where each part must function properly to produce the end results. This is the case with operating systems programs for computers to serve to schedule the machine, balance loads and provide numerous housekeeping and utility services for programmers and users or with such systems as are frequently found in administrative computing (i.e., Students Information Systems, Financial Information System). "Volatility" of software is also a consideration. The volume of expected changes in operating systems, modifications to supporting languages and changes in the policies, rules and requirements of data processing programs seriously affects the ability to share.

It is usually easier to share generalized, less volatile software that serves a large number of users than it is to share a "unique" program which may have a number of volatile procedural, idealogical, policy or data assumptions imbedded in its logic. It is also usually easier to share a single function program than a complex system of programs. For these reasons language compilers, utility programs, and certain calculation packages are readily exchanged whereas complex models and administrative systems programs are far less easy to share. However, the significant costs of creating and maintaining software suggest that significant advantages may result from joint efforts to develop and maintain even complex systems in a common mode.

Data Sharing

The data used with programs can be internal to the program (as with simple calculation examples used in teaching languages) or external (e.g., supplied by reading cards, tapes, disk, etc., called for by the program). Data can also be static (e.g., census data, a data file for classroom program or resulting from a survey) or dynamic (e.g., student transcript, payroll, expenditure). In addition, data bases and files differ greatly in size, complexity and the security/priority/control issues discussed below. Shared data is the exception rather than the rule, although substantial sharing can take place with well-defined relatively common purpose data such as census tapes, Library of Congress book catalog, and various research data bases. Cooperative work can also be profitable in defining data bases, in the common collection of mutually beneficial data and partial, or full exchange of similar data. However, in the exchange of data it should be noted that static data are easier to exchange than dynamic and that simple common formats of data promotes exchange more readily than complex-integrated files. In addition, large volume data stored in cards or tapes can present significant problems in sharing hardware because transmission may be inefficient and the requirement to centrally store, find, and mount tapes or load cards under remote "control" can be very cumbersome.

Security, Priority, Control Issues

Security, Priority, Control issues are factors in the hierarchial complexity of cooperative use of computers. By definition it is more difficult to share software, data and hardware that requires high security, high priority and tight control. Traditionally, considerations of security/priority/control have been largely determined by the nature of applications and administered by significant people/procedural involvement. Although there is a clear trend in virtually all functional areas to provide more "machine or environment" assured security/priority/control, it is still a major factor with regard to cooperative ventures.

Most processing operations (i.e., payroll, student grades, library circulation) require reasonably tight security, have a critical priority and must be closely controlled, whereas student instruction in a language can be done with virtually free, hands-on access to a computer. When both types of functions are to be served in the same computer environment the most restrictive security/priority/control application requirements will set the mode for (and infringe upon) less restrictive applications. Balancing user satisfaction in a cooperative setting may require large investments in hardware and software. For example, interactive processing from a student terminal appears to the user like hands-on computing. But there is a large investment in software and hardware designed to protect other users from each other and the system from crashing because of the actions of one user. It does not always work. The question of how critical a failure is depends considerably on the functional applications involved at the time and the "value-detracted" by failure. A failure that shuts down 32 student terminals for one half hour is generally less critical than a failure that enables a student to wipe out a basic payroll file which in turn might mean that payroll could be a week late. For these reasons the security/priority/control issue must be addressed and solved in such a way as to satisfy the requirements of the most restrictive user.

INTER-INSTITUTIONAL COOPERATION

Considerations

Although the time and resources available to this Task Force did not allow detailed studies of sharing opportunities, the Task Force members do offer a number of points to be considered in more detailed studies of sharing on an inter-institutional basis. These points come from the experiences already available within Ohio, such as in SWORCC and NOUCC, as well as observations on sharing ventures in other states.

Costs of Financial Enterprise

A cooperative venture for sharing computing resources should be set up as a Financial Enterprise (Guidelines for establishing a Financial Enterprise are discussed below). Since there are typically vendor educational allowances, as well as the absence of profit margins, the costs that result are less than commercially obtained service, for the same scale of service. By combining resources from multiple institutions, economies of scale, if present, should result in lower costs than on-campus service. If economies of scale are present, however, the commercial service may take greater advantage of them and this could alter choice.

Benefits of Financial Enterprise

Institutions stand to benefit from the financial enterprise since a uniform charge rate would encourage other users thus magnifying scale economies. Additionally, long-term computer services planning by institutions is simplified since "normal" growth rates can be projected (i.e., In a cooperative venture there is much less likelihood that increased needs from an institution would require step-type changes in computer services budget as can happen when an institution upgrades its on-campus computer center).

Functional Centralization

Economies of scale depend upon the services being offered as compared to the functional needs of the institutions. For example, if two institutions use different data base management systems (e.g., IMS and TOTAL), what are the possible economies of scale? If only one institution utilizes time-sharing services there are no economies of scale achieved in cooperation.

Warren King Recommendation on Sharing

In the Warren King Report of 1969, it was recommended that the State of Ohio be divided into three (3) regions and regional centers formed under the direction of the Board of Regents staff. The centers would provide computer services to the public colleges and universities within their jurisdiction. The recommendation was not implemented for a number of reasons. The Ohio Revised Code does not provide this type of authority to the Board of Regents and a change in the statute was not deemed advantageous. The recommendation was not supported with substantiating data since a thorough study of the advantages and consequences had not been undertaken by the firm.

A similar proposal is now being considered by the legislature involving secondary education in Ohio. A bill has been filed that would divide the state into six regions with a centralized computer facility in each region supporting all of the secondary education needs of the region. The regional centers would be established by the Department of Education at an existing school center or by the creation of a new center.

What has Happened to Date

As an alternative to the Warren King report's centralization recommendation, two institutionally controlled regional centers have been established in Ohio since 1969. The Northwest Ohio University Computer Center (NOUCC) was formed by a joining resolution of the Boards of Trustees of Bowling Green State University and the University of Toledo. The Southwestern Ohio Regional Computer Center (SWORCC) was formed through a memorandum of understanding and a three-year contract signed by the Presidents of the University of Cincinnati and Miami University.

NOUCC was financially supported by a local industry (Owens-Illinois provided 6 acres and $250,000 toward construction of the facility) and the State of Ohio ($2,000,000 for equipment and facility costs). If the agreement of the universities is dissolved by mutual consent as a result of assumption of the maintenance and operation of the Center by the State of Ohio, the member institutions will be reimbursed their capital investments upon such terms and conditions as may be mutually agreed upon by the State of Ohio and the member institutions.

It is intended that both Centers provide computing power to the participating universities as well as any other college or university that chooses to join as a customer or as a part owner.

Guidelines for Establishing a Financial Enterprise

The following guidelines regarding establishment of a Financial Enterprise for sharing computer services are offered by the Task Force.

1. Set up by-laws of the Financial Enterprise
2. Specify the purpose/intent of individual articles to assist in future interpretation
3. Plan for:
    - cost avoidance at **best**
    - lower unit cost for growth at **worst** (particularly when adding new functions)
4. Establish a mechanism for evaluation of the operational efficiency of the enterprise
5. Identify the "computing philosophy" of current and future participants and take this into consideration when planning
6. Identify growth areas (i.e., shifts in academic programs, etc.) of current and future participants and take them into account when planning
7. Identify technological changes, problems, etc. and take them into account when planning
8. Update the by-laws, purposes thereof, and plans frequently

Guidelines for Setting up a Regional Center for Sharing

The Task Force offers these additional guidelines for seting up a structure for sharing computer resources on a regional basis.

1. First regionalize on your own campus
2. Parties must do a thorough job of spelling out financial support, policies, etc. before startup. Then maximum cooperation of the participating institutions is a necessity
3. There must be a strong central management of hardware and system software and close cooperation of application software and technical support must exist
4. As a consortium there can be a rise in efficiency without increased costs because of the following cost reduction factors:
    - cheaper computer cycles
    - cheaper or larger quantities of disk storage
    - faster response or shorter turnaround time
    - availability of special resources (e.g., microfilm output, graphics)
    - availability of a large variety of languages
    - availability of packages to perform particular functions
5. Success depends upon the administration of the enterprise. The controlling board and the administrator must have the same goals and concepts — namely to provide service to the greatest number of participants possible in order to reap the benefits that a combined, powerful computer installation can provide
6. Advantage of a centralized or regionalized computing facility is the availability of resources so that a substantial increase in consumption of computer power units will occur at a lower unit cost per computer power unit than can be experienced in a decentralized facility
7. To achieve this lower unit cost for expansion, a proper long-range plan of at least five years must be developed prior to the formation of such a facility
8. The plan must be developed in such a manner that institutional parochialism is minimized
9. The plan must clearly identify the venture as a financial enterprise totally separate from the participating institutions, yet meeting each institution's needs
10. The document that creates the entity must define an organizational structure and provide a related budget to totally support the entity as a service operation
11. The concept of marketing is fundamental to the success of a regional center
12. Each institution must be sold on the concept of a regional center; autonomy must be bargained away with advantages
13. The concept of customer service is also fundamental to success. Customer service takes up where marketing leaves off, i.e., handling the day-to-day problems that will occur during the conversion of an operation
14. The customer service function is necessary to the user prior to his utilization of the facility

Preliminary Studies of Sharing Conducted During the MIP

As a preliminary investigation of areas of computer services where sharing of resources might be beneficial, a number of studies were undertaken by individual members of this Task Force. It should be stressed that the resources available to the Task Force did not allow for the level of study and analysis necessary for firm conclusions in this quite complicated area of sharing of resources. Much more of an effort must be devoted to the inter-related economic, technological and political aspects of the sharing than was possible during the development of this Computer Services Manual.

Some of the preliminary studies regarding areas of possible inter-institutional cooperation are included in Appendices 6.2 and 6.3 of this Chapter.

Library Circulation System

Appendix 6.2 addresses the issue of finding the most feasible method of sharing The Ohio State University Library Circulation System. The recommendations include undertaking a pilot project with an institution interested in obtaining the full library services available as well as providing software "as is" to any interested institutions.

Social Sciences Data Bases

Appendix 6.3 discusses the use of Ohio State's services in the areas of training, archiving, data dissemination and data conversion in the area of Social Sciences Data Bases.

Time-Sharing

Additional preliminary studies were undertaken regarding the provision of time-sharing computer services on a local basis as well as a study of the merging of the present time-sharing capabilities of The Ohio State University and the Southwestern Ohio Regional Computer Center.

Preliminary indications of the local time-sharing vs. regional time-sharing analysis indicated that CALL/OS from a regional 360 75 may be more expensive for less than 32 users on a per line basis than that available from a 96K PDP/11 located on campus. In the comparison of a newer large machine such as a 370/158 the local PDP/11 machine does not offer the same advantages as the costs tend to be comparable. It should be emphasized in these preliminary results that the level of time-sharing services available from the larger machines is far in excess of that available from the smaller local machine so that a straight cost comparison may be misleading. If the function to be served is elementary languages and concepts, however, the smaller machine may be the correct choice.

The preliminary study on combining the time-sharing services of SWORCC and OSU indicated that both organizations should consider the marketing of time-sharing services for teaching languages and concepts to other campuses in their geographical areas. The study indicated, based upon the assumptions used, that time-sharing could be offered at less than or near the available commercial rates. The study also concluded that OSU and SWORCC should explore the possibilities of providing special language support (e.g., SIMSCRIPT, GPSS) more effectively and developing a mechanism for sharting technical expertise in software maintenance.

Discussion of State Level Involvement in Sharing

The issues of state level control or participation in the shared use of computers need be considered. A number of factors can be identified for having state level involvement in computing sharing.

A balance must be maintained however with the institutional autonomy of the universities. A possible approach to involve universities, other users and the state that has been tried in other states involves the formation of not-for-profit educational corporations. The educational cooperations could be controlled by a board of directors composed of public university and college representatives, Board of Regents representatives and possibly private college and university representatives. The board of directors should represent the highest level institutional and state level policy makers plus users in instruction, research, administration and public service areas of the institutions.

Statewide involvement in supporting various information exchanges, planning and evaluation services through the Ohio Board of Regents and statewide support of cooperative ventures could also be valuable to inter-institutional sharing.

Recommendations

Having discussed the approach to sharing that this Task Force feels most logical and likely to achieve benefits (i.e. functional commonality), as well as some history of sharing within Ohio and the nation, the recommendations of this Task Force regarding inter-institutional cooperation will be addressed.

The Task Force recognizes that all of Ohio's universities and colleges will benefit from further, well planned, cooperative efforts in appropriate computer services areas. It must be stressed that economies depend upon the type of service being shared, and this in turn determines what functional areas are appropriate for cooperation. For example, although every institution has need for keypunching, sharing of keypunching via a centralized keypunching facility would not be appropriate. However, many institutions have need for interactive time-sharing and pooling of resources in the establishment of a centralized facility providing time-sharing to a portion or all of Ohio's public institutions may be advantageous. The centralized time-sharing facility could be an expansion of an existing campus or regional center facility or the establishment of a new center.

The Task Force believes that within the board functional areas of computing discussed elsewhere in this manual, specifically,

- Teaching Languages and Concepts
- Problem Solving
- Production Processing

there are significant opportunities for cooperation with regard to hardware, software, and data. Addressing the problem in a functional need context permits the evaluation of the cost-effectiveness of a particular alternative or set of alternative opportunities.

The Task Force recognizes that the best approach for capitalizing on the sharing opportunities involves detailed study and analysis of the economic, technological and political factors and is not at all readily apparent.

The Task Force recommends that an Ohio statewide plan for computer services resource sharing among institutions of higher education be developed.

Development of the plan should be directed by the Ohio Board of Regents and should involve direct participation by the public universities and colleges as well as interested private institutions of higher education. Because of the near certainty for future cost avoidance through the implementation of the findings of the planning effort, **the Task Force recommends that the State of Ohio provide the Board of Regents with the necessary resources sufficient to accomplish the study in a manner that will assure meaningful results.** That is to say to approach the development of the plan in a piecemeal way, leading to unsubstantiated conclusions because of lack of time or resources, is without merit.

The planning effort should involve addressing all statewide higher education computing applications from the standpoint of "functional need" and then evaluating the alternative costs of providing computing services and/or software to those which are common. Examples of candidates for inter-institutional cost-effective service could prove to be, for example,

- Languages and concepts through remote batch service,
- Languages and concepts through interactive time sharing,
- Problem solving via remote batch service.

Possible steps in developing the statewide plan would be along the following lines:

1. Audit the present software, hardware and data resources, what exists now and how is it being utilized.
2. From a functional viewpoint determine the present demonstrated needs of Ohio's higher education institutes and estimate what will be needed in the future.
3. Identify a list of potential functional candidates for sharing software, hardware, data or services to meet the present or future needs. Evaluate the feasibility and cost-effectiveness of the most promising alternatives for meeting the needs on an inter-institutional basis.

Role of Regents Staff

The Task Force recommends the following roles for the Board of Regents staff in the Computer Services Area:

1. Each time the Master Plan is created by the Board of Regents, a computer services component of the plan should be included. The computer services component will be used by computer services planners and administrators in the same manner as university administrators presently use the Master Plan.
2. Board of Regents staff pursue the feasibility of statewide acquisition of computer based management decision-making tools.
3. The Board of Regents staff plan and conduct one- and one-half-day computer services seminars for all University and College Presidents and Chief Executive Officers. The purpose of the seminar is to acquaint the officers of the institutions with the present status and trends in computing, the capabilities, limitations and potential of computers in solving problems within the university, and to answer specific questions they may have regarding computers. The goal of the seminar is to increase the awareness of the officers with regard to the manner

in which the computer can assist them to direct the university resources on an administrative and instructional level. The seminar will involve business leaders, computer manufacturer representatives, private consultants, university computer services specialists, academic representatives and Board of Regents staff. There will be no marketing presentation of equipment since this can be obtained on a local level. Topics for discussion will be solicited from the participants prior to the seminar.

4. The Task Force recommends that the Board of Regents staff contact computer service vendors regarding the feasibilities of joint purchase, lease, or rental in order to reduce university expenditures through various types of discounts (e.g., quantity).

Appendix 2.1

TECHNIQUES FOR FORECASTING

Forecasting techniques can be subdivided into two basic categories with a number of techniques within each.

I. Judgmental forecast techniques
  a. Judgmental forecasts
  b. "Delphi" method
  c. Scenario method

II. Model-based Forecasts
  a. Analytical models
  b. Simulation models
  c. Intrinsic models (Curve Fitting, Time Series)
  d. Extrinsic models (Regression, Econometric. Input/Output)

Ia. Judgmental Forecasts

In this most fundamental and perhaps the most frequently used technique, future values of a variable are predicted by directly specifying their level. Although this technique is sometimes criticized as being unscientific, it is probably true that an experienced forecaster takes into account far more information and processes this information more consistently than many "model-based" techniques. A danger seems to come when inexperienced persons make forecasts and when individual forecasts are merged into "consensus" forecasts. In these situations the lack of formality in both forecasting assumptions and analysis quite often result in inadequate projections at any point in time and in inconsistent projections through time. Those responsible for computer service planning should ensure that the assumptions used by those involved are uniform, well understood and in agreement with the assumptions being employed by upper management.

Ib. "Delphi" Method.

The technique has been used to forecast future technological events by a method of iterations. Basically, experts respond (anonymously) to a well-defined forecasting question. The responses are then statistically summarized, returned to the experts, and revised forecasts are prepared. The procedure ends when a consensus or total lack of consensus is achieved. The procedures merit lies in its ability to maximize the advantages of group dynamics in forecasting while minimizing the problems caused by dominant personalities and silent experts.

Additionally, the "Delphi" method uitility also lies in its use of a large sample of experts. This may not generally be the case within a computer service unit. A mini-Delphi method may be used within a university or, possibly of more benefit, computer services directors could employ the technique on an inter-institutional basis to answer common forecasting problems. Such problems might include the duration of vendor support of older model computers, the most likely timing and significance of future equipment announcements, the growth rates of CAI on campus, the effects and timeliness of significantly lower cost of core storage.

Ic. Scenario

The procedures are initiated by postulating a formal set of assumptions (a scenario) about the future environment. Logical arguments are then utilized to develop various specific consequencies of these assumptions and these consequencies form the basis for the forecast.

II. Model Building Forecasts

The majority of model building forecast techniques involve a description of the situation in mathematical terms such that the outcomes of various change can be quickly and economically established through mathematical computation. The computer is used in most model building forecasts if there is some complexity and this has led to the development of a number of simulation languages (GPSS, SIMSCRIPT, PLANTRAN) as well as application programs available in computer libraries.

The simulation languages allow the fast development of the mathematical model of the process and this in turn allows quick response to "What if" types of questions.

Some general types of application programs provide detail quantative information regarding a number of areas of concern to computer service management.

buy-lease projection
cashflow analysis
growth projections
Monte Carlo simulation
depreciation expense
linear regression
PERT

The use of these pre-programmed packages is usually cost effective since no development time need be spent—all that is required is the submission of the appropriate data and (what is sometimes overlooked) an understanding of the underlying assumptions in the model.

Appendix 3.1

UNIVERSITY OF CINCINNATI BILLING SYSTEM

In order to formulate an equitable billing system the primary necessity was to identify the costs involved and secondarily to determine the distribution of these costs. Since equitable distribution of cost was mandatory, each tangible operation had to be costed. These operations included core residency, CPU time, and input/output operations. The following is a sample itemized billing report that appears on every computer output listing printed at the University of Cincinnati.

```
       PREVIOUS ACCOUNT BALANCE                      $29841.16
   213 CARDS READ                    @      .00190         .40
   776 LINES PRINTED                 @      .00150        1.16
     0 SPECIAL FORMS LINES           @      .00150         .00
     0 CARDS PUNCHED                 @      .00520         .00
     0 SPECIAL CARDS PUNCHED         @      .00520         .00
 11069 TAPE I/O OPERATIONS           @      .00100       11.07
   326 DISK I/O OPERATIONS           @      .00040         .13
     0 HIGH SPEED KB MIN.            @      .00125         .00
   512 LOW SPEED KB MIN.             @      .00075         .38
     0 HIGH SPEED CPU SEC.           @      .07080         .00
   130 LOW SPEED CPU SEC.            @      .05333        6.93
     0 PRINTER FORM CHANGES          @     5.0000          .00
     0 PUNCH FORM CHANGES            @      .50000         .00
     3 TAPE DATA SETS                @      .50000        1.50
     5 LOGICAL DISK MOUNTS           @      .50000        2.50
       TOTAL JOB CHARGE                                  24.07
       NEW ACCOUNT BALANCE                           $29817.09
```

Unit Record or Remote Terminal Rates

The following is the theory involved with formulation of the above rates.

Equipment Costs

In order to charge equitably for computing services in the three different areas (academic, administrative, and medical) of Computer Services, it was necessary to itemize the equipment, personnel, and supply costs directly allocable to each area. In addition, the cost of other equipment, although shared among divisions, can be divided in accordance with past utilization derived from statistics compiled over the last two years. For example, statistical analysis indicates that 50% of the utilization of the 2540 Card Reader/Punch, located in the central computer room, can be allocated to Academic Computer Services. This type of itemization was done to determine the rates for the academic, administrative, and medical divisions of Computer Services.

Personnel Costs

Some personnel costs, such as programmer time, keypunch time, and systems analyst time should be directly recoverable under the new billing procedures. Therefore, a rate for recovering these costs will be determined separately, and, none of the people will be included in determining overhead or operational rates. Costs for administrative, clerical, and operating personnel are not directly recoverable. In their work, these people are primarily involved with computer input and output (I/O). These costs were billed to the user on the basis of I/O activity. If an academic user is responsible for 2% of the total I/O activity for all academic users, then he should be billed for 2% of the personnel costs associated with that activity. In that academic personnel are not involved in ADP I/O activity, etc., it is reasonable to divide these costs among the divisions on the basis of actual costs incurred.

Supply Costs

In the determination of I/O or remote terminal rates, supply costs within each division are distributed among the various types of input/output activity (punching cards, printing special forms, printing stock or plain forms, reading cards) on a percentage basis. For example, statistical analysis indicates that, on the basis of printer utilization, the administrative area is responsible for 30% of the cost of printer ribbons. Further analysis indicates that of the total lines printed by the administrative area, ⅔ is on standard forms and ⅓ is on special forms. Therefore, in determining the cost to the administrative area of lines printed, ⅔ of the cost of ribbons was allocated to standard forms line costs and ⅓ to special forms line costs. The cost of special forms will be borne by the individual user.

I/O Rates

On the basis of the above equipment, personnel, and supply cost distributions, precise I/O rates were developed for each type of I/O activity within each division and for tape I/O operations. The average number of academic unit record I/O operations in a month is 18,065,000. The number of standard forms lines printed is 14,500,000. This is 80% of the total. Therefore, the equipment cost associated with academic standard forms lines printed is 80% of the total equipment cost less supply costs. The personnel cost is also 80% of the total. The total cost, when divided by the number of standard forms lines printed yields the academic standard forms line rate.

Magnetic Tape Rates

In determination of the cost of tape I/O activity (reading or writing data to a magnetic tape), the following special considerations are significant. In addition to the tape drives, related control units and channels, the personnel cost of one computer operator per shift was allocated to tape costs. This is a reasonable allocation because without tape mounting and associated activities the central computer facility could run with one less operator per shift. The personnel costs of three tape librarians were split between the cost of tape I/O activity and the cost of tape storage. For tape storage, an overhead cost was added to the monthly personnel cost. This includes the cost of tape racks depreciated over a three year period. The total monthly cost of tape storage divided by the number of chargeable tapes stored in the library yields the tape storage rate.

Magnetic Disk Rates

The cost of disk storage and disk I/O primarily involves equipment costs. These include the cost of the disk drives and their related control units, the cost of the selector channels, and the cost of the disk packs themselves. This total disk cost was recovered through four different channels. A rate was charged for logical disk mounts, i.e., allocation of a disk data set or file. This is a legitimate system overhead cost and was felt a reasonable charge based on charging schemes from several other installations. A rate is charged per disk I/O read or write operation. This rate is used to recover the cost of thirty overhead disk packs (packs that must be permanently mounted to meet the requirements of the operating system and the three divisions). Different rates per track, or recording area, are charged for permanently resident and mountable disk space. The cost of a mounted spindle, or spindle rate, is the total disk cost divided by the number of logical spindles.

EXCP Rate

The permanent residence of certain packs is required by the operating system. Other packs must be permanently mounted to meet the day-to-day operating requirements of the three divisions and normal development. In number these various packs total twenty-four, excluding teleprocessing packs which are charged for separately. The cost of such a permanently resident pack is simply the spindle rate. Dividing this figure by the average number of disk input/output operations per month times one hundred, yields the disk I/O rate per hundred I/O operations (EXCP's).

Permanently Resident Space Rate

The permanent residence of certain packs is required to meet the requirements of certain individual computer users or user departments. On the average, 75% of the space on these packs is actually allocated. The total cost of these packs must be recovered from this alloacted space. Since a disk pack contains 4,000 tracks, 75% allocation can be translated into 3,000 tracks. The cost of permanently resident disk space can then reasonable be assumed to be the spindle rate divided by 3,000.

Mountable Disk Space Rate

The remainder of the total cost of disk operations was recovered from space allocations on mountable disk packs, i.e., packs that are not permanently resident. Of the total cost, there are twelve mountable packs on which space can be allocated. On these disk packs, as with permanently resident packs, allocation averages 75%. Therefore, a mountable disk space allocation rate can be determined as the associated cost divided by the number of mountable packs (12) times 3,000 tracks. (Through extensive study and experimentation a near optimal mix of off-line and on-line packs has been achieved. A significant increase in the number of off-line packs would have a detrimental effect on this mix and, by increasing the number of required pack mounts, seriously degrade overall system performance.)

Residency Rates

Residency rates involve the cost of core storage only. This includes the cost of two megabytes of Ampex ECM core and five hundred kilobytes of IBM high speed core. The remaining 256K of high speed core was included as an overhead cost in the CPU rate calculations. The allocation of the cost of this 256K of core as a system overhead in the CPU rates is legitimate in that this region is used by the operating system in servicing system and data management requests issued by a user job. The frequency of these requests is a function of CPU utilization, not residency. Kilobyte-minutes (KM) is the resident time for a job, from start to stop, times the region used in kilobytes. KM for high speed and ECM reflects only batch processing. Residency rates are determined by dividing the total cost of core storage by the total KM in each category.

CPU Rates

CPU rates were calculated in a manner similar to unit record rates. Equipment costs include costs of equipment directly related to the CPU and not otherwise recoverable. The cost of core storage was not included since this is recovered through the residency rates. The exception is the cost of one high speed core box (256K) which is included as overhead for the operating system. Personnel costs include the cost of all departmental administrative, technical, clerical and operating personnel not otherwise recoverable. These total costs are distributed in relation to the percentage of monthly CPU time in high speed and low speed core. The rates are then developed by dividing the total costs in each category by the associated monthly CPU minutes.

Teleprocessing Rates

The cost of a teleprocessing system can be broken down into four categories: teleprocessing equipment, disk I/O, core residency, and CPU utilization. The TP equipment and disk costs are incurred regardless of actual TP system utilization. They are a function of the number of users each system is required to support. Therefore, these costs were recovered as a flat rate per month to each TP system user. Core residency cost is a function of the number of users that can utilize a TP system concurrently. These costs are directly related to the amount of time each user is logged on the system. This is referred to as connect time. For CALL/360 and CRJE, which do user connect time accounting, this residency cost will be recovered in relation to user connect time. For other TP systems, this cost was included in the calculation of a flat monthly rate. CPU utilization cost is a function of the work performed by the CPU for a user while he is logged on a TP system. Only CALL/360 does user CPU utilization accounting. For CALL/360, this cost was recovered on that basis. For other TP systems, this cost was included in the flat monthly rate. The salaries of three programmers were added to TP costs to allow for programming time spent modifying and maintaining the TP systems. This is divided among the TP systems according to time spent. In the TP rate calculations TP equipment includes conversational and video terminals billed to University Computer Services, teleprocessing control units, video display control units, telephone equipment and lines, and leased private communication lines. Disk costs are computed at the permanently resident space rate. Number of users, connect time, and CPU time are based on current utilization. CPU cost is derived from past utilization at the slower core storage or ECM rate.

Hybrid Center

The Hybrid Computer Center has both rented and purchased equipment. The cost, therefore, includes depreciation on the purchased equipment as well as monthly rental, personnel and departmental administrative costs. Usage is estimated on the basis of recent experience.

Development of Central Administrative Costs

Central Administrative Costs are distributed among the various billing areas by percent of personnel cost in that area, as determined in each area. Items included in departmental administrative costs are supervisory in nature or control in nature, such as managers and couriers, telephone and Xerox costs. It is therefore reasonable to assume that, if an academic user uses 2% of the resources allocated in a month to the academic area, he will be charged for 2% of the administrative cost involved with that area.

Plots

Costs for plotting include plotter software and the accompanying hardware. The total cost was divided by the estimated monthly usage for rate determination. No personnel costs were included since the operator time involved is often overlapped by performance of other duties.

Computer Output Microfilm (Com) Rates

Equipment Costs

The COM equipment and supplies can be divided into two categories; that equipment and supplies required to produce the original microfiche, and that required to produce duplicate fiche. Approximately fifty percent of the equipment required to produce original fiche has been charged to general overhead and is therefore recovered in the CPU rate. This is valid because of the use of the COM for lengthy core dumps taken when operating system problems occur. Each storage dump produces eight original fiche cards. The equipment and supplies costs which must be recovered in producing original fiche includes the COM unit, film processor, film, and chemicals. For duplicates, the costs include the film printer, and developer.

Personnel Costs

The personnel costs incurred in COM output consists of the operator time required to perform the various operations necessary to produce the original fiche or duplicates. Based on the estimated volume of fiche, it will normally require two hours of operator time per day to produce the original fiche and three hours of operator time per day to produce duplicates.

Optical Scanning Rates

Equipment Costs

The only equipment costs involved with the optical scanning is the Scanner itself. This cost was recovered in the set-up charge of $2.00 plus a per sheet charge. It should be noted that any batch computer processing of the Scanner output tapes is billed at the standard rates for CPU time, I/O operations, etc. OpScan forms are billed on a cost basis. Special forms and forms design are also billed on this basis.

Personnel Costs

The personnel costs incurred in optical scanning include the cost of the operator to run the OpScan machine. Since operator time required can greatly vary in relation to the condition of the OpScan forms, it was deemed more equitable to charge for operator time on an as used basis rather than a per sheet basis. The rate charged was at the actual cost of operation.

Forms

Billed at cost.

Forms Design

Billed at cost of design personnel.

Alternate Unit Record Rates

Alternative Unit record I/O rates which are uniform for all divisions were determined from total costs and total I/O operations in each category, and leaving out separate special lines charges, since there will be a special forms set-up charge. Special forms printing requires extra operator effort in the form of ribbon, print chain, and paper changes, and ties up equipment needed by other programs. This set-up cost has been determined to be $5.00 per set-up, with 1200 set-ups per month.

Programming and Keypunching Rates

Since addition of the programmer and keypunching costs to either the remote terminal, residency, or CPU costs would have resulted in an unusually high cost to some and yet an unusually low cost to others, separate rates were developed for each area. Costs for programming include departmental administrative, personnel, equipment (terminals, keypunches), travel, telephones and education. The charge for programming was determined by dividing total costs by total hours less vacation, sick leave, breaks, holidays, etc. This same method was used for development of the keypunch rates.

Appendix 3.2

AN OHIO STATE UNIVERSITY BILLING SYSTEM

The Ohio State University Systems Computer Center

January 8, 1973

Schedule for Data Processing Operations

Computer charges are determined in two usage categories:

1. On-line Processing
2. Batch Processing

On-line charges are calculated in the same manner as batch processing except that terminal equipment and support facilities are directly charged to the user as specific fixed costs based on the particular equipment configuration.

Computer Charges

On-line terminals and support facilities:

Description	**Monthly Rate**
CRT display with speeds above 120 cps	$250.00
CRT display at 120 cps or slower	150.00
Hard copy terminal with speeds above 30 cps	250.00
Hard copy terminal at 30 cps or slower	150.00
Hard copy terminal with magnetic tape cassette	250.00
Dedicated high speed memory (units of 2K)	25.00
Disk storage (units of one million characters)	10.00

Batch processing charges are based on the usage of four distinct computer resources:

1. CPU (Central Processing Unit)
2. Core Storage
3. Input
4. Output

To account for jobs being processed on different computers (thus different speeds and capabilities), CPU and Core Storage resources are calculated in terms of charge units as follows:

Charge units for CPU $=$ minutes of CPU utilization
Charge units for Core $= (\text{Core}/100\text{K})^{1.25} \times$ minutes used/15

Input is charged on the rate of 1190 input cards per dollar.

Output is charged at the rate of 4200 lines or 800 cards per dollar plus any of the following charges as appropriate:

a. Non-default forms at actual material cost
b. $.50 set-up cost for each non-default form used
c. $1.00 set-up for cost for each non-default output class

APPENDIX 3.2

Total job cost is the sum of these preceding four resource factors. The costs of a charge unit for CPU and core are:

370/145	$1.26 per charge unit
370/155	$3.78 per charge unit

Non-Computer Operations Charges

Machine #	Machine Description	Functions Performed	Est. Speed	Hourly Rate
029	Key Punch	Punch	4M strokes/hr	$3.95
129	Card Data Recorder	Verify	6M strokes/hr	3.95
		Interpreting	810 cards/hr	
083	Sorter	Numeric or	60M cols./hr	4.18
		Alphabetic	30M cols./min	
084	Sorter	Numeric or	120M cols./hr	4.18
		Alphabetic	60M cols./hr	
557	Alphabetic Interpreter	Numeric or Alpha	6M cards/hr	4.18
519	Card Reproducer	Numeric or Alpha	6M cards/hr	3.91
188	Card Collator	Merge	39M/hr	5.59
		Match	39M/hr	
		Sequencing	39M/hr	
3270	VIDEO terminals	Entry	4M strokes/hr	4.25
		Verifying	6M strokes/hr	4.25
		Inquiry	see CRT Display	
703	Binder	Bind reports		3.44
1500	Burster	Disconnect Continuous forms	4.5M to 12M ft/hr	3.51
727	Deleaver	Remove carbon from multi-part forms		3.44
1722	Trimmer-Imprinter	Trim margin perforations, Sign pay checks, etc.		3.51
2400	Continuous forms Xeroxing		2400 copies/hr	.02 per copy
2400	Single master Xeroxing (non-continuous)		1800 copies/hr	.02 per copy
200	Scan-Data	OCR processing		75.00/hr

Other Charges

Clerical Services	5.00/hr
Technical Services	$ 7.50/hr
Programming & consultation	10.00/hr
Delivery	50.00/month

Appendix 3.3

ILLINOIS EDUCATIONAL CONSORTIUM STUDY REGARDING COOPERATIVE ADP SYSTEMS DEVELOPMENT (FEB. 1973)

Illinois ADP Study

A recent study (February, 1973) was conducted by the Illinois Educational Consortium for Computer Services (a voluntary organization of the Senior Illinois Universities) on administrative application development in Illinois public institutions of higher education. The results of the study shed some light on the factors inhibiting mutual development and/or sharing of ADP applications between academic institutions.

The overall objectives of the study were to:

Study Objectives

- analyze and identify those factors which appear to cause universities to develop individualized administrative systems
- make recommendations aimed at improving the capability of universities to cooperatively develop and/or exchange application systems.

Potential for Cooperative Efforts

The consortium made a number of observations that they believe supported the contention of the Illinois Board of Higher Education that the area of administrative systems development is one which has great potential for future cost avoidance if centralized or joint development efforts can be undertakn.

1). The greatest increases in data processing costs in recent years appear to be those related to people rather than hardware. A potentially fertile area for personal cost avoidance appears to be ADP application development.

2). It would appear that there has been relatively little cooperative effort in administrative application development in higher education to date.

3). With the development of new colleges and proliferation of community colleges considerable opportunity exists for avoiding future costs of undergraduate ADP development at each institution.

4). The success of software companies such as IBM and Systems and Computer Technology in marketing generalized and/or easily modifiable application programs to higher education indicates that it is possible to centrally or cooperatively develop administrative systems.

Factors that have Inhibited Cooperative Efforts

The consortium then identified 10 casual factors, related both to the nature of ADP itself and the unique aspects of the institutions within which ADP functions, that can be cited for what appears to be an inabilty on the part of higher eduaction to cooperate in the development of ADP Application Systems.

1). Traditionally ADP systems were developed for a specific user demand within an institution. The demands tended to be uncoordinated and only infrequently directed toward deriving institution-wide as opposed to departmental benefits.

2). There has not existed any adequate technique or set of standard by which an institution can compare or evaluate existing ADP systems at other universities.

3). The professionalism of most ADP analysts, programmers and managers results in an emphasis upon the ability to create original application systems.

4). Professional differences between users often accounted for differences in administrative data systems.

5). Difference in the mission and organization of each institution tended to color the nature of its ADP applications.

6). Existing documentation has often been inadequate for sharing application systems.

7). ADP systems may be several years old and are technologically obsolete.

8). Differences in hardware configurations.

9). The requirement that ADP professionals be aware of what other institutions are doing has never been a specific assigned responsibility.

10). The political atmosphere which exists between users between ADP and its users, and between ADP and the general administration often tends to impact the design of ADP.

Recommendations of Study

The consortium then made a number of recommendations:

1). Consortium should establish, in cooperation with the institutions, common data elements, and code standards, programming and documentation standards, and ADP audit standards and services.

2). Consortium recommends that cooperative systems development efforts be undertaken in certain non-critical application areas as pilot projects under the auspices of the consortium and further supports the concept of cooperative systems development as being more appropriate than that of centralized systems development.

3). Consortium proposes that cooperative systems development projects be initially undertaken which are not critical for any institution and which do not require major interaction with existing application systems already operational on the campuses.

4). Organize a statewide ADP systems exchange similar to national effort of CAUSE.

5). Establish consortium as prime contractor for purchasing proprietory software products.

6). Develop equipment and personnel inventory document.

7). Consortium provide or acquire statewide training services for institutions professional staffs.

Appendix 4.1

HARDWARE AND SOFTWARE MONITORS

Performance Monitoring

Before the advent of multi-programming within third generation computers, it was a relatively easy task to determine how efficiently each piece of computing equipment was being used. The concurrent execution of multiple programs makes this determination more difficult. Performance monitors, however, are available that have the capability and have been used successfully at computer installations to gather data regarding the actual status, (i.e., busy or wait) of critical components (e.g., central processing unit (CPU). channels, peripheral devices) of the computing equipment. In some cases users have found that they can both downgrade this configuration and at the same time increase their throughout.

The performance monitor records events such as CPU busy, channel X busy, CPU in wait state, etc. The data gathering portion is followed by another phase wherein an analysis is performed on the recorded events and a report is generated. The report provides information on utilization at a level that is not available with job accounting packages.

Types of Monitors

Performance monitors are available in hardware monitors or software models.

Hardware Monitors

Hardware monitors consist of high impedance probes that are physically inserted into the computer circuits. The other ends of the probes are connected to counters generally through some logical circuitry. By sensing electrical signals within the computer, the monitor can count events during a time period or determine a time period between sucessive events. In addition to the probes, counters and logical circuitry for event or time interval counting, analysis programs are provided in order to analyze the raw data and for preparing the performance reports. Hardware monitors have the following characteristics:

Advantages:

- do not increase computer overhead
- applicable to many makes and models of computers
- can make direct measurements on peripheral device:

Disadvantages:

- learning to use hardware monitor requires substantial amounts of time
- chance of error in placing probes on wrong point

Software Monitors

Software monitors perform the data recording function through a routine that is resident in main memory during the measureemnt process. One technique involves the use of interrupts of the processing during which the software quickly samples the status of designated components and, in effect, asks if the CPU is busy, if the printer is busy, etc. As with the hardware monitors, analysis and reporting routines are provided for preparing the measurement reports.

APPENDIX 4.1

Software monitors have the following characteristics

Advantages:

- generally easier to learn to use than hardware monitors
- more versatile in that it can collect as much or as little data as is required, based upon its results

Disadvantages:

- only be used with a specic hardware/operating system configuration
- it uses memory space, CPU cycles and channel time

Use of either hardware or software monitors results in the following problem areas:

- need for monitor specialist
- decision regarding data to collect and measurements to take
- decision regarding interpreting results

Experience with Monitors

Third generation computing experiences with monitors began about 1967-1669 when independent companies were formed to develop and market monitors. In higher education, Brigham Young University (BYU) loacted in Provo, Utah became interested in monitors in 1970. They acquired and employed rather successfully portable hardware monitors for their on-campus computer monitoring. As their experience grew with hardware and software monitors, they consulted for other organizations and began to offer two-day seminars on performance monitoring.

The director of computer services at BYU, Dr. Gary Carlson, has stated that there are three goals for monitoring (1) to save money (2) to understand the system better, and (3) to indicate trends that will lead to better service and lower costs. His claim is that in all of his and his associates' experience to date, they have always been able to find ways to both reduce the size (and/or cost) of a configuration and at the same time increase its throughout. Their main attention has been devoted to configuration utilization, because this seems to provide the greatest payoffs from monitoring. Benefits are also obtained by improving inefficiently coded programs.

Costs for Performance Monitoring

The costs associated with monitors are the salary of one or more specialist(s) and the cost of the monitor. Purchase costs range from $9,000-$35,000 for today's leading hardware and software monitors. If monitor specialists are employed for approximately one week, the cost, including use of the monitor, would be about $2,000 per installation with multiple installation cost saving arrangements possible. Independent consultants with extensive monitoring experience would be preferable if outside services are desirable, since no equipment bias would exist such as that which might occur with computer manufacturers, peripheral equipment suppliers or monitor suppliers.

Appendix 6.1

EXAMPLES OF EXISTING COMPUTER NETWORKS

California State University and College Network

**California State University and Colleges
Distributed Computer Network**

The distributed network was created in 1969, and under the direction of the Office of the Chancellor, provides computing access to approximately 275,000 students and faculty in California's 19 state colleges. The host computers are two CDC 3300's, regional computers located in the northern and southern part of the state, a CDC 3170 computer for time sharing at San Fernando Valley College and an IBM 360/91 at UCLA for unique software request or excessive computing power. The four host computers are interconnected and service computers such as IBM 360/40's, IBM 360/20's, CDC 3150, and an NCR Century 200 on the 19 campuses. The network configuration as of April, 1972 is illustrated in Exhibit 5.3.

The original design called for 80 percent of the computing to be accomplished locally and 20 per cent at the regional centers.

California made a deliberate effort to combine the instructional and administrative workloads in this network. The emphasis was to allow instruction to be handled locally on campus. Each college with more than 5,000 fulltime students was given a stand alone computer for instruction.

The percentage of the types of computing being completed locally and centrally are as follows:

	Locally	**Regional Centers**
Instructional	85%	25%
Research	5%	25%
ADP	10%	50%

In the development of the local campus facilities the first two priorities were:

(1) to provide computer services to student and allow faculty to expand computer-based courses
(2) to provide increased capability for faculty to do research.

At the regional centers the priorities which were used as guidelines were:

(1) administrative
(2) instruction

The systems software, as well as the planning and policy making, were centralized.

APPENDIX 6.1

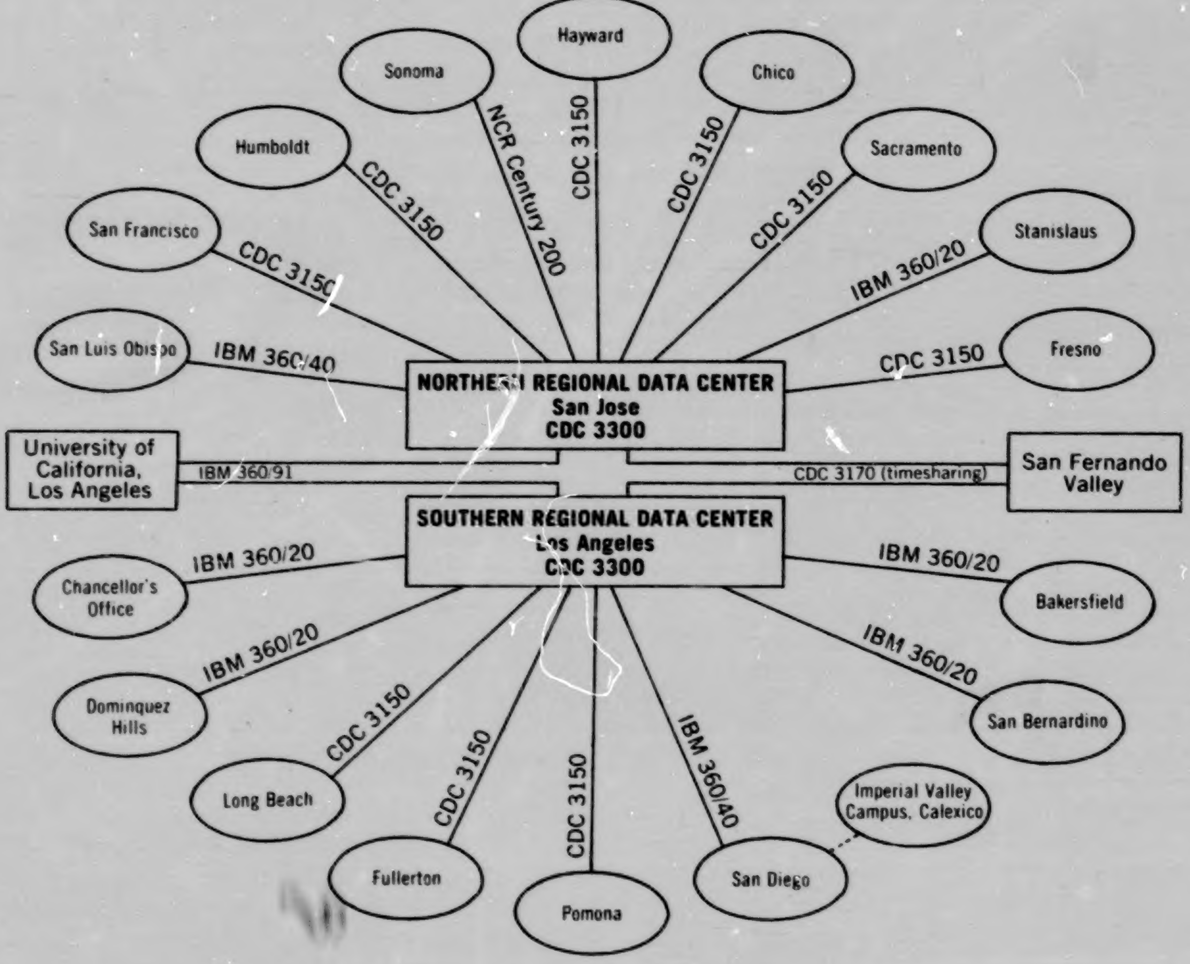

Hayward
Sonoma
Chico
Humboldt
Sacramento
San Francisco
Stanislaus
San Luis Obispo
Fresno
NCR Century 200
CDC 3150
CDC 3150
CDC 3150
CDC 3150
CDC 3150
IBM 360/20
IBM 360/40
CDC 3150
NORTHERN REGIONAL DATA CENTER
San Jose
CDC 3300
University of California, Los Angeles
IBM 360/91
CDC 3170 (timesharing)
San Fernando Valley
SOUTHERN REGIONAL DATA CENTER
Los Angeles
CDC 3300
IBM 360/20
Chancellor's Office
IBM 360/20
Bakersfield
IBM 360/20
Dominquez Hills
IBM 360/20
San Bernardino
CDC 3150
Long Beach
CDC 3150
CDC 3150
IBM 360/40
Imperial Valley Campus, Calexico
Fullerton
Pomona
San Diego

EXHIBIT 6.2
DISTRIBUTED COMPUTER NETWORK—THE CALIFORNIA STATE UNIVERSITY AND COLLEGES—April, 1972

TUCC

Triangle University Computer Center (TUCC)

TUCC was formed as a private corporation in 1965 in order to realize economics through computer load sharing. The three owners of TUCC and their associated equipment are:

DUKE UNIVERSITY
- 360/40 as a terminal
- both I/R and ADP being done at TUCC

UNIVERSITY OF NORTH CAROLINA
- 360/75 as a terminal
- I/R—50% handled locally and 50% at TUCC
- ADP—separate computer on campus
- Public Service—separate computer on campus

NORTH CAROLINA STATE UNIVERSITY
- I/R work done at TUCC
- ADP IBM 360/40

The TUCC does not develop any application programs but rather only provides computing access. The charging algorithm was set up such that as your level of service, compared to the other universities, increased your turnaround time would increase.

The problems associated with TUCC have been:
(1) Daily courier service required for tapes, etc.
(2) TUCC not as sensitive to local needs

The factors that contributed to TUCC's success are:
- Proximity of each university to TUCC (15 miles)
- History of close cooperation among universities
- Legislature made TUCC facility a local call from each university

A change that has taken place since the development of TUCC has been the addition of a HASP-to-HASP capability that allows load leveling between any of the four computers — the TUCC and the three university computers.

Merit

Michigan Education Research Information Triad, Inc. (MERIT)

The primary goal of this arrangement between Wayne State University (WSU), Michigan State University (MSU) and the University of Michigan (UM) was for the sharing of resources, that is, to obtain service not available locally. The MERIT effort has been assisted by a $400,000 grant from the National Science Foundation (NSF) and a matching grant from the State of Michigan.

The three host computers are two IBM 360/67's and one CDC 6500.

UM 30,000 FTE students
I/R computer IBM 360/67 (duplex) with 70-80 terminals
ADP computer

MSU 35,000 FTE students
I/R computer CDC 6500, CDC 3600
ADP computer (2) 360/40's (1) 360/30

WSU 22,000 FTE students
I/R computer —)
) 360/67 (duplex)
ADP computer —)

The major problems associated with MERIT have been the handling of one university charging another for time, especially when one university becomes a center of gravity causing balance of payments problems.

The advantage of MERIT lies in the variety of computers (CDS's), data files (local) and software (IBM's) that are available to each participant.

APPENDIX 6.1

New Jersey

New Jersey Educational Computer Center

A public not-for-profit corporation was formed to provide computer related services to the state's public and private colleges. There is a 19-member board representing the user institutions, the Chancellor of Higher Education and the public.

The network uses three large computers that had been installed at Princeton and Rutgers prior to the formation of the corporation. Fifteen public and five private colleges receive services. Both resources sharing and cost savings have been the objectives. The corporation has contracted with a commercial firm for some application program software development. The host computers for the network are:

Princeton University
  IBM 360/91
  IBM 360/67

Rutgers University
  IBM 360/67

Iowa

Iowa State and University of Iowa Network

In August 1971 the University of Iowa (UI) in Cedar Falls and Iowa State University (ISU) in Ames interconnected their IBM 360/65's in order to gain economies through load balancing. In addition to the transfer of computing work there is also splitting of specialized software acquisitions and maintenance of software systems. For example, one school acquired the Statistical Package for the Social Sciences (SPSS) and makes it available to the other university.

ARPA

Advanced Research Projects Agency (ARPA) Network

This Department of Defense sponsored nationwide network was established in 1969 for resource sharing among the large research oriented universities in the country. Hardware, software and data files are currently being shared by 25 participating installations. In addition to the large host computers there are Interface Message Processor (IMP) computers that provide for access to the host computers and Terminal Interface Processor (TIP) computers that handle the interface between terminals and the network without the help of a local host computer.

The resources available on the ARPA network are substantial and therefore this nationwide network must be considered when computer sharing alternatives are examined within Ohio. A possible approach would be to have at least one university or regional center within Ohio connected to the ARPA network and making access available to other users within the state. This would involve the interconnection of regional centers and/or university computer centers in a distributed computer network with all users having access to the ARPA network. This situation would be similar to the one in California where all colleges in the network have access to the UCLA 360/91 machine.

Appendix 6.2

AN EXAMPLE OF A PRELIMINARY STUDY OF POSSIBLE AREAS OF INTERINSTITUTIONAL COOPERATION

April 27, 1973

TO: Hugh Atkinson
Weldon Ihrig
Carroll Notestine
James Randels

FROM: George W. Baughman

SUBJECT: Interinstitutional Cooperation with Library Circulation System.

Problem:

Costs of circulating books have been increasing rapidly, control of circulation has become increasingly difficult and increasing demand for library services coupled with reduced budgets has made it imperative that higher education find economical ways to better utilize their library holdings.

The O.S.U. Library Circulation System has provided a product that can dramatically increase utilization, improve control and at the same time reduce the per volume cost of circulation. This system can have enormous cost benefit implications to other institutions as well. The question is how can it be most feasibly provided?

Considerations:

At a meeting on April 3, the basic economics of the system of O.S.U. were discussed as were alternatives for providing the benefits of this system to other institutions.

The system, which permits faculty, staff, and students to have searches done by phone in less than two minutes, and volumes sent to them by campus mail when available has:

1. Saved over 100 years of faculty time in searching per year (1,25,000 faculty searches now made by phone).
2. Saved an equivalent amount of student search time annually.
3. Permitted O.S.U. to nearly double circulation with only a nominal increase in books.
4. Enabled O.S.U. to keep cost per circulation stable or declining whereas other institutions report increases of from 4 to 10% per year.
5. Provided a vehicle for greatly expanding the availability of library services to a large geographical area at a modest cost. For example, the typical cost of finding out if a book is available at O.S.U. through the traditional method of writing a letter with associated follow-up is over $10.00. A two minute long distance call can now accomplish the same.

Software for the system was purchased at a cost of $250,000 and has had four full time programmers/analysts involved in maintaining and improving it since its introduction in the fall of 1971. The program is well documented and could be readily adapted to another institution. However, the specific volume files and patron files would need to be created separately for another institution in that call numbers, lending restrictions, etc., would need to reflect institutional norms. Numerous institutions have evidenced interest in the system as has the State of New York for statewide implementation.

O.S.U. could provide the software to another institution that had adequate personnel and hardware capacity for installing and maintaining it. This would create an immediate "savings" of over $350,000 to that institution.

O.S.U. could also provide full hardware and software services to another institution on a cost of services basis by July of 1974 if a decision were "known" by August 1973. The latter alternative is more attractive in that it would permit sharing future development costs and greater economics of hardware uilization.

Hardware costs at O.S.U. are about $35,000 per month and provide on line access to 2.5 million volumes via 40 terminals and 16 cathode ray tubes (CRT) sixteen hours per day. A rough estimate of the hardware cost of adding another system about the size of O.S.U.'s with 35 terminals would be $12,000 per month plus line charges. Savings here are attributable to the fact that the programs are modular and that the modules are not core resident so a "new system" would only require a minimal increase in core. A consideration for sharing would be that no degradation in response time would occur.

The system would be appropriate to any higher education institution that wanted or needed to:

1.) Dramatically reduce search time on the part of faculty, staff and students.

2.) Increase circulation and control of existing volumes without increasing the cost per circulation.

Recommendations:

1. That O.S.U. undertake a pilot project with an interested institution to develop the feasibility of providing full service to that institution.
2. That O.S.U. agree, as a less acceptable alternative, to provide software on an "as is" basis to another institution that has the hardware and software support services required to operate and maintain the system.

EXHIBIT A

O.S.U. Library Circulation System
Fact Sheet

1. Operating Data:

On line files:
2.5 million volumes
80,000 patrons

Annual Searches:
1.25 million faculty
1.25 million student
——
2.50 million

Annual Charge Outs:
1.0 million
Operates 16 hours per day

2. Hardware:

370/155 — .75 megabytes
Core required — 188,000 bytes (programs are non-resident)
Disk — 300 million

Terminals:

CRT	16
Typewriter	40
	56
Monthly cost of above	$35,000

3. Software:

Initial Purchase	$250,000
Maintenance & Improvement	100,000
	$350,000

Continuing maintenance — 4 F.T.E. systems analysts/programmers

4. File Creation:

Roughly 12¢ per title or $300,000 for 2,500,000 volumes.

Appendix 6.3

AN EXAMPLE OF A PRELIMINARY STUDY OF POSSIBLE AREAS OF INTERINSTITUTIONAL COOPERATION

May 30, 1973

TO:	Regents MIP Task Force on Computing	
FROM:	George W. Baughman	
SUBJECT:	Interinstitutional Cooperation on Social Sciences Data Bases.	
PARTICIPANTS:	Richard Hofstetter,	Profession of Political Science and Director of Polimetrics Laboratory, O.S.U.
	Randall Ripley,	Chairman, Dept. of Political Science, O.S.U.
	David Smith,	Associate Dean, College of Social and Behavioral Sciences, O.S.U.

Problem:

Social scientists are making greater use of large and diversified data bases in machine readable form in their research. This creates a need for 1) faculty training in data access and analysis methods, 2) access to data sets, 3) archiving and data reduction services and 4) appropriate computer hardware and software to run these problem solving jobs.

The Ohio State University currently meets a large number of these needs for a variety of departments through the services of its Polimetrics Laboratory in the College of Social and Behavioral Sciences which represents the "user" in dealing with the Instruction and Research Computer Center. Some or all of these services could be provided to other institutions in Ohio on a cost effective basis. The question is what services and to what institutions on what basis?

Considerations:

The following alternatives were considered:

1. Exchanging data bases.
2. Providing Training Services.
3. Providing Archiving and Data Conversion Services.
4. Providing Computing Services.
5. Combinations of the above.

A general restriction on some data bases occurs by the agreement with the supplier. For example, a large number of data bases come from the Inter-University Consortium for Political Research at Michigan. These can only be shared with other members of ICPR under our current agreement. As of 1971 Akron, Bowling Green, Cincinnati, Kent State, Miami, Ohio University and Wright State were other Ohio members of ICPR as was Dennison and Oberlin.

APPENDIX 6.3

Findings:

1. Over 700 data bases including 1970 Census Data, U.N. World Trade Data, and voluminous international election, opinion, demographic, political attitude and military sources are currently used by O.S.U. The majority of these would be open to members of ICPR.
2. Training in the use of these data bases is not readily available elsewhere in the U.S. and frequently involves sending a faculty on sabattical to capture the state of the art. Our experience here shows that training in the use of data can successfully be provided in a major workshop and exposure to concepts can be accomplished in a weekend seminar.
3. The basic investment in even a modest archiving and data concession service will run over $25,000 per year for a single institution.
4. Consulting on the use of various data bases and implementation services (interfacing with the Computer Center) are extremely important to most faculty members here.
5. Batch services with over-night turn around are generally satisfactory for this kind of problem solving. Interface services are important here in assuring that central cards, file descriptions etc., are correct.
6. A basic package of two short workshops and one major (10 day) workshop plus archiving, data reduction and some consulting services could be provided at a full cost (including overhead) of about $50,000 annually. With ten institutions the cost would be $5,000 per institution which is less than the cost of just acquiring the ICPR data bases alone.

Recommendations:

1. That O.S.U. offer training, data base, archiving, data conversion and data dissemination services to other institutions in Ohio.
2. That a market survey of institutions in Ohio be conducted to assess a level of interest in supporting such a project.

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